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DE LAMAR LECTURES

THE JOHNS HOPKINS UNIVERSITY
SCHOOL OF HYGIENE AND PUBLIC HEALTH

DE LAMAR LECTURES
1925-1926

BY

David Marine, Alice Hamilton, Francis Carter Wood, Frederick W. Sears, Thomas Adams, W. G. Smillie, Edward R. Baldwin, Louis I. Dublin, Joseph Goldberger, C. R. Stockard, Horace Lo Grasso, Robbins B. Stoeckel, Sir Arthur Newsholme

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DE LAMAR LECTURES

A series of popular lectures in personal and public hygiene is arranged each session, by the School of Hygiene and Public Health of The Johns Hopkins University.

The object of these lectures is to bring before the public the general facts and points of view of modern hygiene, with the hope that in this way the School may serve as a center for the distribution of useful knowledge in all matters pertaining to sanitation and preventive medicine.

These lectures are supported from the fund bequeathed to the Medical School by Joseph R. De Lamar, in accordance with the wish expressed in his will "to give to the people of the United States generally the benefits of increased knowledge concerning the prevention of sickness and disease and also concerning the conservation of health by proper food and diet."

PREFACE

The De Lamar Lectures in Hygiene were instituted by the School of Hygiene and Public Health in 1920 to carry out in part the wish expressed by Joseph R. De Lamar in his will, "to give to the people of the United States generally the benefits of increased knowledge concerning the prevention of sickness and disease and also concerning the conservation of health by proper food and diet." The De Lamar bequest was made to the Medical School of the University, but in order to meet as fully as possible the desires expressed by the donor, a portion of the income was made available to the School of Hygiene and Public Health. With the funds assigned to them this latter School established a *Journal of Hygiene* and made provision for an annual series of public lectures by leading authorities in public health with the intention that thereby new and important developments in preventive medicine and hygiene might be brought before the students of the school and the public in general. In order to give the lectures as wide a currency as possible it was desirable to have them published for general distribution, but circumstances were such that in the beginning it was not found practicable to carry out this intention. A satisfactory arrangement has now been made with The Williams & Wilkins Company, of Baltimore, to gather the lectures together in a printed volume at the end of each series. It is hoped that this plan will be effective in making these valuable contributions known to a wider audience. The present volume includes only the lectures given in the sixth series, session of 1925–1926, as it has not been feasible to assemble all the material presented in the preceding series, although many of the lectures previously given have found publication in journals of various kinds. The scope of the lectures is very broad. In a few cases they have been historical, but in general they have dealt with the newer ideas and movements that constantly arise in all the many phases of public health work. It is a pleasure to express our thanks and appreciation to the distinguished lecturers who have responded so readily and so cordially to our request for their assistance.

W. H. Howell,
Assistant Director.

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PREVENTION OF SIMPLE GOITER AS A PUBLIC HEALTH MEASURE

DAVID MARINE

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INTRODUCTION

One of the most important results of the thorough teaching of the sciences of physiology and pathology is the gradual unfolding to the student of medicine of the limitations of curative medicine. As our knowledge of these two subjects broadens we are unconsciously, as it were, led to the conviction that some means of combating disease other than by cure must be developed if we are to cope successfully with many of the more serious causes of ill health, incapacity, and suffering. My four years as a student in this university created this impression which has increased during the succeeding years. Whether their knowledge of pathology and physiology per se had anything to do with the selection of Professors Welch and Howell as directing heads of this School of Hygiene and Public Health or not, it has always seemed to me singularly fortunate for the school that physiology and pathology should have been given such prominent positions during its formative period.

With such convictions regarding the importance of physiology and pathology in Public Health and Preventive Medicine in mind, I shall utilize most of the hour reviewing the physiology and pathology of the thyroid gland and touch only briefly upon the actual prevention of goiter.

When one realizes that our first definite knowledge of the function of the thyroid began in 1874 when Gull definitely associated a clinical disease now known as myxedema with atrophy of the thyroid all will agree that great advances in our knowledge of the organ have been made.

Gull's observation was followed in 1882–1883 by the publication of Kocher's paper on his results of total extirpation of the gland for goiter in man. Many of these cases developed tetany but others developed a peculiar clinical picture which Kocher named *cachexia strumapriva* and he recognized the similarity of this experimentally produced myxedema with the spontaneous disease as described by Gull. Horsley in 1885 in a large series of monkeys obtained a few cases of *cachexia strumapriva* after thyroidectomy but most of his animals died of parathyroid tetany. The thyroid and parathyroid glands were first definitely separated functionally in 1891 by Gley. This physiologist, using the rabbit, showed that the consequences of their removal were quite different. Unfortunately, the complete separation of the function of these glands to the satisfaction of all workers did not occur until about 1910 despite the important observations of MacCallum in this university and many others.

The final proof of the relation of the thyroid to myxedema was added in 1891 when Murray cured a case by injecting a glycerol extract of fresh sheep's thyroid. Baumann of Freiburg in 1895 made the most important discovery concerning the physiology, namely, the normal presence of iodin. He observed that the iodin was firmly bound with some protein of the gland and isolated a substance by acid hydrolysis containing 9–14 per cent of iodin which he called iodothyrin. Iodin had been knowingly used in the treatment of goiter since 1820 and it is surprising that no one sought for it in the gland until seventy-five years later. (Kocher once told me that he had asked the chemists to examine the thyroid for iodin in 1880, but the chemists reported negative results.) Baumann and his pupils further showed that feeding iodin increased the store of this element in the gland and that feeding fresh meats tended to lower it. They found that in general normal glands had more iodin than goiterous glands. Oswald in 1899 showed that the iodin was bound with the colloid or globulin, and that in general the iodin varied directly with the amount of stainable colloid. In spite of all this work, the idea that the iodin of the gland was deposited there as a waste product and served no important physiological purpose was strongly held.

In 1905 we began an extensive study both experimental and statistical of the relation of iodin to the gland structure in man, dog, sheep, ox and pig. The maximum iodin store in the normal human thyroid is about 30 mgm., while the average is about 15 to 20 mgm. Seidell and Fenger have shown seasonal variations in animals, the iodin being highest in the early autumn and lowest in the early spring months. Our work definitely showed in all the animals studied that there was a very clear relationship between the iodin store and the histological structure of the gland, the store being highest in the normal and lowest in the markedly hyperplastic glands, and that when the store was above 0.1 per cent no histological changes occurred, whereas when the store fell below this level hyperplastic changes usually were present.

From these studies the generalization was made that the iodin varies with the amount of colloid and inversely with the degree of hyperplasia. This generalization was tested experimentally in several ways:

First, iodin was fed to dogs with hyperplastic thyroids after having removed bits for control and without exception we observed involution or a return to the colloid state and a rapid storage of iodin in the gland. These observations were then extended to other mammals, also to birds and fish with the same result. In the dog it takes about two weeks to thus involute a hyperplastic thyroid while in the brook trout it requires thirty to forty days in summer.

Secondly, we studied the effect of iodin on compensatory hypertrophy following partial removal. As many observers have shown, notably Halsted in 1889, if one removes one-half to three-fourths of the thyroid of dogs the remaining portion undergoes hyperplasia histologically identical with that occurring in the spontaneous hyperplasias of developing goiters. We found that the administration of small amounts of iodin by mouth would completely inhibit this regeneration after removal of as much as three-fourths of the gland in the dog and rabbit. Loeb has reported he could not prevent the compensatory hypertrophy of the thyroid in guinea-pigs by the administration of iodin, and Halsted in repeating his experiments in 1889 was unable to reproduce compensatory hypertrophy, and thought his observations in 1889 were due to wound infection. The most probable explanation of his later results is that the animals came in contact with some source of iodin. One can safely conclude that iodin will prevent the compensatory hypertrophy of the thyroid after removal of as much as three-fourths of the gland and that the administration of desiccated thyroid or the preformed hormone will further protect against hypertrophy of the thyroid after removal of as much as five-sixths of the gland.

Thirdly, Halsted first showed that the young of bitches from whom he had removed most of the thyroid had markedly enlarged thyroids at birth, the enlargement being as much as twenty times the normal size. This observation has since been confirmed by several observers, notably by Carlson, Edmunds and Lenhart and myself. We were able to add the additional fact that if one removed most of the maternal thyroid during the first week of pregnancy and gave iodin in small doses during the pregnancy the puppies at birth would have normal thyroids, and we were further able to obtain from the same bitch alternate litters of goiterous and non-goiterous puppies merely by the withholding or the administration of iodin. These observations as so often happens merely confirmed the old clinical conception of congenital goiter in man, viz., that it in some way was dependent upon a maternal thyroid deficiency.

Fourthly, we carried out further series of experiments to show whether small amounts of iodin would prevent thyroid enlargement in dogs living in highly goiterous districts. For this purpose we took the litters of puppies from mothers that had been given small amounts of iodin during the pregnancy in order to insure normal thyroids at the beginning of the experiment. To a part of each litter was given 1 mgm. of iodin once a week by mouth, keeping the remainder of the litter as controls. We found that this amount of iodin prevented hyperplasia while the control puppies living in the same kennels and eating the same kind of food regularly developed thyroid hyperplasia.

These experiments indicate that iodin plays a very important rôle in controlling the morphological changes in the thyroid.

I shall now point out a few of the most important facts dealing with the relation of iodin to the pharmacological activity of the thyroid. In 1895 Magnus-Levy showed that the metabolism in cases of myxedema when measured as heat production is markedly reduced, even to 30 or more per cent below the normal. When he fed these cases with desiccated thyroid their heat production rose to normal or even above. This observation has been universally confirmed both for spontaneous and for experimental myxedema. Increased metabolism still remains the most characteristic pharmacological action of the thyroid. More recent studies have shown that the effect of thyroid on metabolism varies with, and is dependent upon its iodin content. This effect has been demonstrated by studies on gaseous and nitrogenous metabolism, by studying its effect on the metamorphosis of tadpoles as developed by Gudernatsch and by the acetonitrile reaction as developed by Reid Hunt. Hyperplastic thyroid with no iodin is as inert physiologically as sweetbread. I have on two occasions purchased in the meat markets of Cleveland large goiterous calves' thyroids exposed for sale as sweetbread.

The final proof that the action of desiccated thyroid was dependent upon an iodin containing hormone was obtained by Kendall in 1916 when he isolated the iodin containing compound in crystalline form and named it thyroxin.

Broadly defined then our present conception of the function of the thyroid is that it provides the means through its iodin containing hormone for maintaining a higher rate of metabolism than would otherwise obtain, and also through fluctuations in its activity it provides one of the means for varying the rate of metabolism to meet the changing physiological needs. On the basis of this brief outline of the function of the thyroid the diseases associated with disturbances of its function I believe may be divided into two broad groups as follows:

I. Thyroid insufficiencies
    1. Simple goiter (sporadic or endemic)
    2. Myxedema
        a. Infantile (cretinism)
        b. Adult (Gull's disease)
II. Graves' disease (hyperthyroidism, thyreotoxicosis)

First, a word about Graves' disease. I have included it among the thyroid diseases though personally I do not believe it primarily belongs there. The thyroid changes in this disease appear to be secondary to some obscure derangement of the function of the visceral nervous system and are probably compensatory in nature. If this view should ultimately prevail then the thyroid changes found in this disease would be similar to those found in the thyroid insufficiencies and all the objective evidence of morphology, chemistry, and function is in support of such a view.

Let us now turn to the thyroid insufficiencies, one manifestation of which, namely, simple goiter, is the major topic of this lecture. Simple goiter and myxedema are usually considered separately in clinical medicine but from the standpoint of physiology and pathology they are only different degrees of the same nutritional fault. This close relationship between simple goiter and myxedema has been most clearly and definitely expressed by Morel as follows: "Goiter is the first step on the road to cretinism."

OCCURRENCE AND DISTRIBUTION

Simple goiter includes those thyroid enlargements in man and animals which were formerly grouped under endemic, epidemic, sporadic, congenital, adolescent, physiological, etc. It may occur in any land and fresh water animal with the ductless thyroid. Animals living in the sea are free from the disease. It occurs in all races, in all climates and at all habitable altitudes. In the temperate zones there is a seasonal variation both in man and animals which coincides with the seasonal variations in the iodin store already referred to. While goiter may occur anywhere, one of the most striking characteristics is the increased incidence in certain more or less defined regions—the so-called districts of *endemic* goiter. The most notable of these districts are the Himalaya mountain region of South Central Asia, the Alps, the Pyrenees and the Carpathian mountain regions of Europe, the Andean plateau of South America. In North America the most important areas are the St. Lawrence River Valley and the Great Lakes Basin extending west through Minnesota, the Dakotas and the adjacent Canadian provinces and also the Pacific Northwest including Oregon, Washington, and British Columbia. It will be noted that most of these regions are mountainous, although there are numerous exceptions. Of greater importance is the occurrence of endemic goiter for the most part on soils deposited during the last glacial period.

There are many reports of the sudden occurrence of goiter in large numbers of men and animals, the so-called *epidemics*. These so-called epidemics in man have for the most part occurred in military garrisons, in institutions, and in schools. These outbreaks have usually been in districts where the ordinary incidence of goiter is high and in new inhabitants. They also occur in domestic animals. I have had the opportunity of investigating such outbreaks in dairy herds, poultry farms, and in fish hatcheries. Some of these outbreaks were in goiter regions, while others were not, showing that with the optimum conditions for its development present, goiter may occur anywhere.

The periods in life when simple goiter most frequently develops are, (1) during fetal life, (2), during puberty, (3) during pregnancy and lactation, (4) during the menopause.

Beginning about the age of puberty, females are more often affected than males. In districts of severest endemic goiter this difference in incidence due to sex is masked. In non-goiterous regions where only sporadic cases occur these are usually seen in women. Striking an average between these two extremes one may say that in general simple goiter is two or three times more common in females. In the lower animals a difference in incidence due to sex has not been demonstrated.

ETIOLOGY

The cause of goiter has interested medical men from the earliest days of medical history, and during the last 2500 years a great variety of agents have been brought forward as causal factors. St. Lager in 1867 grouped these theories under forty headings. Many of them must now be considered as folk-lore and legendary in nature. Poverty, unhygienic living conditions, unbalanced diets certainly are important indirect contributing causes. McCarrison states that it is a common saying in certain provinces of India that people who can afford the luxury of table salt are less likely to be affected. A great variety of organic and inorganic substances both of known and unknown chemical nature, occurring in soil and water have been suspected to be the cause. Among these may be mentioned arsenic, salts of calcium and magnesium, sulphides, particularly of iron, fluorides, silica and miasms from decomposing vegetable matter. These substances are not now believed to play any direct rôle. With the development of bacteriology and protozoology, the view that thyroid enlargement might be due to a specific living virus was widely adopted. This view has been the basis of extensive investigation. Many types of parasites, bacteria, fungi and protozoa have been described. McCarrison has worked extensively in this field in India and formerly believed an organism of the colon group was responsible. Infection he believed took place through drinking water and food. Chagas, working in Brazil in 1909, reported a form of goiter which he thought was due to a trypanosome. Subsequent work has shown that infection with this organism may exist without thyroid enlargement and that thyroid enlargement may exist without the infection. Kolle of the Swiss Goiter Commission failed to produce thyroid hyperplasia in rats by inoculating them with cultures of this organism. The occurrence of this infection in a district of endemic goiter readily explains the association.

Numerous experiments in which fresh and boiled water from the supposedly goiter producing springs were employed have been carried out in recent years by Wilms, by Dieterle, by Hirschfeld and Klinger, by Bircher, and by the Swiss Goiter Commission. These experiments have yielded either negative or doubtful results. In general nothing suggesting a direct infecting agent has been proven despite the enormous amount of work which has been done. That toxins of bacterial and other origins may indirectly stimulate the thyroid to increased activity and possible enlargement is well known. Thyroid enlargements are frequently seen in early pulmonary tuberculosis, in active syphilis, and in some of the more acute fevers. The thyroid reaction in these conditions is now explained as dependent upon its increased function in febrile diseases which in turn brings about the increased metabolism and indicates that the thyroid is an element in the defensive mechanism against infection and intoxication.

Water has been associated as a carrier of the active goiter producing agent by all peoples from the remotest times. The conflicting experimental data thus far reported can perhaps be better interpreted as pointing to the lack of some substance (iodin) necessary for the prevention of thyroid enlargement rather than to the presence of some virus or toxin capable of producing thyroid hyperplasia. My own interest in water as a carrier of the goiterogenic agent ceased in 1911 when

Lenhart and myself demonstrated that brook trout living in the most polluted water readily recovered from thyroid hyperplasia although the trout living in artificial ponds both above and below the runway were highly goiterous. If water is a factor in producing thyroid hyperplasia (and I believe it is) it is due to the absence rather than to the presence of some substance.

Turning now to the present view of the etiology of simple goiter, this assumes that goiter is a work or compensatory hypertrophy of the thyroid depending upon a relative or an absolute deficiency of iodin. On this basis goiter is only a symptom of a specific deficiency disease in which an insufficient supply of iodin from one cause or another is the chief factor. This deficiency of iodin may be due to (1) factors which bring about an abnormally low intake of iodin, (2) factors which interfere with the absorption or utilization of an otherwise adequate intake, (3) factors which temporarily increase the needs of the body for the iodin containing hormone, i.e., which create a relative insufficiency. These groups may be examined further:

Group 1. Factors bringing about an abnormally low intake: This would explain endemic goiter. The idea that goiter is due to a lack of iodin is not new. As early as 1830 such views were expressed. The work of Chatin, published in 1852, deserves special mention. He showed that there was a lack of iodin in the soil and water in districts of endemic goiter. His results were attacked and unfortunately so discredited on the grounds of faulty and inadequate methods that further study of this important work was blocked for forty-five years. During the last ten years very extensive analyses of foods, soils and water for iodin have been made and all of them confirm Chatin's claims of a marked reduction of the iodin in the soils and waters of goiterous districts. I have already pointed out that one can cause experimental hyperplasia by withholding iodin.

Group 2. We have no definite information at present of factors which cause an interference with the absorption and utilization of otherwise adequate amounts of iodin. It is conceivable that intestinal bacteria or intestinal parasites can utilize or divert part of the iodin intake.

Group 3. There are many factors which temporarily increase the needs of the organism for the iodin containing hormone, that is factors which bring about a relative insufficiency. Among the more important may be mentioned, (*a*) food, (*b*) pregnancy, (*c*) infectious diseases, (*d*) puberty, (*e*) Graves' disease. *Food* has long been known to influence the thyroid. St. Lager mentions that the Alpine people believed that excessive eating of pork fat caused thyroid enlargement. I have already mentioned that Baumann observed that feeding lean meat caused a reduction of the iodin store in the thyroid. Since then much work has been done showing that meat can cause thyroid enlargement, among which are our observations on a diet of pig's liver and goiter in brook trout. In 1920, McCarrison published work showing that diets which include an excessive amount of lard or digestible fat free from iodin were very potent in producing thyroid hyperplasia in pigeons. We have confirmed McCarrison's observations using cotton seed oil on rats and rabbits.

Pregnancy. This is one of the important causes of thyroid enlargement. Lawson Tait pointed out the stairstep-like enlargement of the thyroid gland with succeeding pregnancies. Slight enlargement of the thyroid during pregnancy is looked upon by obstetricians as normal. This enlargement has the characteristics of a work hypertrophy dependent upon increased demands for functional activity during the period. In general the metabolism of pregnant women, dogs, and rabbits rises during the second half of pregnancy 25 to 35 per cent above that obtaining in the non-pregnant state. Without going into the question whether all of the increased metabolism comes from the developing fetus, it is a fact that removal of the maternal thyroid early in pregnancy in rabbits abolishes the increase without interfering with the pregnancy, and one must conclude that much of the thyroxin and all of the iodin necessary for this increased oxidation comes from the mother. If, therefore, the iodin intake is not correspondingly increased to meet the increased demands the store of iodin is gradually depleted, and, as already pointed out, when the iodin store in the thyroid falls below the critical level (about 0.1 per cent per gram dried gland) hypertrophy begins. On the other hand, if the store of iodin is maintained above this level the hypertrophy is usually prevented. I had the opportunity while in Cleveland of coöperating with the obstetric department of the School of Medicine, Western Reserve University, in the study of a large group of pregnancies with and without the administration of iodin.

Infections. I have already pointed out that the iodin store of the thyroid may also be reduced by infectious diseases. Again, the probable explanation is that increased functional demands are made upon the thyroid at this time. Enlargement often occurs in pulmonary tuberculosis, in active syphilis, and in other forms of infection, particularly the so-called focal infections (teeth, sinuses, etc.). As an illustration of the relation of infections to thyroid enlargement, we found five cases among 2200 girls where thyroid enlargement occurred in spite of the fact that they had taken all of the prophylactic treatments with sodium iodide for a period of two and one-half years. Careful examination of these five girls revealed one case of congenital syphilis, and the other four had adenoids, enlarged tonsils with histories of recurring attacks of tonsillitis.

Puberty. This is the most important period in life when simple goiter develops. Again, all the existing evidence indicates that the enlargement is a work hypertrophy dependent upon a reduction of the iodin store. Why the period of puberty should bring about greatly increased demands for thyroid activity, we have no definite information beyond the general belief that the rapid growth and development occurring at this period brings about a distortion of the normal balance of internal secretions. The same morphological and chemical changes in the thyroid occur during the puberty enlargements as are seen in the compensatory hypertrophies following partial removal, in the hypertrophies of pregnancy and of infections.

Lastly, I shall mention the thyroid enlargement seen in *Graves' disease*, as a compensatory or work hypertrophy dependent upon a relative deficiency of iodin. In 1911 we published our experimental, chemical, and pathological data on the thyroid gland in exophthalmic goiter and came to the conclusion that the thyroid reactions in this disease were in no way different from those seen in other clinical associations. To quote,

> There were eleven cases in which the patients were treated with iodin for one to three weeks prior to operation. In all of the cases the iodin contents of the thyroids were markedly raised but in none had complete involution to the colloid state occurred. There were four cases which had received iodin for periods varying from two months to eighteen months and in all complete involution to the colloid state was present at the time of operation. We can, therefore, reasonably conclude that the active

hyperplasia of exophthalmic goiter has the same characteristic of rapidly taking up iodin that characterizes all the active functional hyperplasias and also that iodin induces a similar series of morphological changes in the exophthalmic goiter hyperplasia as in other active thyroid hyperplasias and that these changes are histologically identical with those occurring in spontaneous involution (recovery).

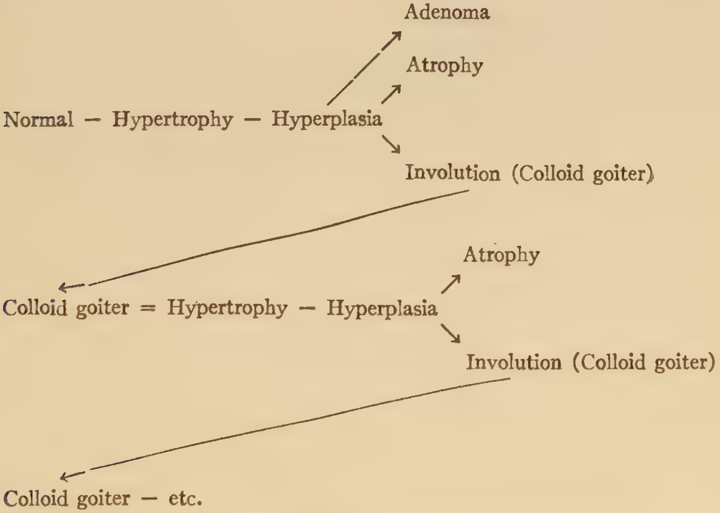
To sum up, the available evidence indicates that simple goiter is a compensatory or work hypertrophy depending upon a variety of metabolic stimuli for functional activity of the thyroid which reduces its iodin store. The immediate cause of thyroid enlargement is a relative or an absolute deficiency of iodin which may be brought about by (1) factors which cause an abnormal low intake, (2) by factors which interfere with the absorption or utilization of an otherwise normal intake, and lastly (3) by factors which temporarily increase the needs of the organism for iodin. I have mentioned specifically *diet*, *pregnancy*, *infectious diseases*, *puberty*, and possibly *Graves' disease* as specific instances of a relative insufficiency bringing about thyroid enlargement.

The first group depends upon a definite, simply defined and easily understood factor—an actual deficiency of iodin—whereas the third group which depends upon a relative or temporary insufficiency is more difficult to define, less understood and by far the most important since no animal with the ductless thyroid is ever free from the possible influence of one or another of the factors of diet, pregnancy, puberty, infections, etc. These factors are as active in goiterous districts as in non-goiterous districts and when combined with a real iodin starvation the effects would be exaggerated. It is very important to distinguish between group one and group three. So much emphasis has been laid on the iodin deficiency of late that there is a tendency to assume that all thyroid enlargement is due to a real iodin starvation and to lose sight of the fact that the deficiency may be only relative to temporarily increased demands.

PATHOLOGICAL ANATOMY

In any discussion of the pathological anatomy, it should be borne in mind that the thyroid is one of the most labile tissues in the body. It may undergo proliferation or involutionary changes within a few days and on this account too great physiological and pathological importance is often attached to morphological changes. In addition, the thyroid may be the seat of a large variety of pathological changes, such as regeneration, involution, degeneration, hemorrhage, cyst formation, tumor, atrophy, and all may be present in a single specimen as pointed out by Virchow in 1863. To quote his words, "It has long been held that there are many varieties of goiter. This is wrong. All the so-called varieties are none other than different terminal metamorphoses of a single type, and a large and striking variety of pathological changes may be combined in the same goiter."

A workable classification therefore must be one which includes only the major types of essential changes and sequentially arranged in the order of their manifestation. Attempts to formulate such a classification from an extensive study of human material ended in failure. From the study of large series of normal and uncomplicated goiterous thyroids from the lower animals (dogs, sheep, ox, pig, brook trout and fowls) we have been able to construct a graphic outline of the changes meeting the above requirements. This graph is as follows:


Adenoma
Atrophy
Normal — Hypertrophy — Hyperplasia
Involution (Colloid goiter)
Atrophy
Colloid goiter = Hypertrophy — Hyperplasia
Involution (Colloid goiter)
Colloid goiter — etc.

The most important change in the thyroid in developing goiter is the decrease in the iodin store. When this falls below a critical level (in our experience around 0.1 per cent per gram of dried gland) morphological changes begin. These are characterized by a decrease in the stainable colloid, an increase in the blood supply and a progressive change in the alveolar epithelium from flattened cuboidal to cuboidal to columnar. If the process continues infoldings and plications of the epithelium occur. Different animals show variations. Thus, in man and in birds the colloid tends to accumulate and causes a passive dilatation of the alveoli even though the gland is poor in iodin and still actively hyperplastic. The initial and essential changes in the thyroid of developing goiter are however qualitatively the same in all animals.

After the thyroid has become hyperplastic one or the other of two further fundamental changes occurs. In the first place, spontaneous or induced involution or recovery may occur at any stage of the hyperplasia and the great majority of all hyperplasias spontaneously involute. In that event, the iodin store rises, the colloid accumulates and distends the alveoli and the epithelium returns to its cuboidal form. A thyroid in this condition is in its resting stage and is designated colloid goiter. This is the nearest normal condition anatomically and chemically that a gland once hyperplastic can ever again assume. As indicated in the graph such a gland can repeat the cycle of active hyperplasia and involution many times during the course of the animal's life.

In the second place, the hyperplasia may go on to exhaustion atrophy. This condition occurs if the thyroid cells are compelled to function at a high rate without periods of physiological rest. It is seen particularly in the late stages of progressive Graves' disease and in the last stages of severe simple goiter going on to the clinical condition known as myxedema. The most characteristic anatomical changes in exhaustion atrophy are fibrosis, and changes in the epithelial cells characterized by great variations in size, atypical mitotic figures, irregular, small and large nuclei which we have interpreted as indicative of the struggle for existence that finally ends in cell necrosis unless physiological rest is obtained. One of the most striking illustrations of this extraordinary capacity of thyroid cells to recover their equilibrium if given physiological rest may be seen in the young cretin animal, several instances of which we have been able to follow experimentally.

Human goiter and to some extent goiter in the white rat are characterized by the presence of localized areas of more rapidly growing thyroid cells scattered irregularly through the gland—the so-called adenomata. These localized areas by their more rapid growth acquire a false capsule by pressing and stretching the surrounding thyroid tissue. The nature of these growths is not understood. They may arise in utero or at any time after birth either from the undifferentiated thyroid, the so-called fetal rests of Woeffler, or from adult thyroid cells, that either through a better blood supply or through some more obscure influence on their finer nutrition undergo a more rapid growth. In their beginning they are usually if not always associated with diffuse hyperplasia of the gland as a whole. These nodules have some of the attributes of tumor in that their growth may not be arrested by iodin administration yet they retain many of the characteristics of normally functioning thyroid as, for example, their ability to produce thyroxin, their spontaneous recovery and the fact that the stimulus for their growth is identical with that which initiates growth of the more differentiated thyroid tissue.

Finally, on account of the thyroid's capacity for rapid growth and involution, on account of the superficial location of the thyroid and on account of its great functional variations, numerous and important secondary changes are of frequent occurrence. The most important of these are hemorrhage and its sequelae, the several degenerations, necrosis with cyst formation, diffuse or localized fibrosis, calcification and ossification.

PREVENTION

The search for methods of prevention was one of the major functions of the Goiter Commissions appointed by the Sardinian government in 1845, by the Swiss government in 1908, and more recently by the Italian government. The methods recommended by these Commissions closely followed the theories of the cause of goiter prevailing at the time. Changing the water supply was one of the most important recommendations. In some instances this is stated to have decreased the incidence of goiter, while in others it has increased it, notably in Vienna, Portland (Oregon), and Seattle. In view of the proved relation of iodin to the normal and pathological physiology of the thyroid it was but natural to attempt to control thyroid enlargement by supplying iodine in amounts that roughly might approximate the normal physiological demands. The first occasion where iodin was thus used in the prevention of simple goiter on a large scale was in 1909 when Lenhart and myself demonstrated that this substance added to the water supply in a concentration of about one part per million, arrested and prevented thyroid hyperplasia in brook trout. Since then the administration of iodin in some form or other has been successfully applied in the prevention of goiter in practically all domestic animals.

Our attempts to apply the plan for the prevention of goiter in man met with determined resistance, and we were not able to overcome this difficulty until 1917 when with the aid of Dr. O. P. Kimball we began such an experiment among the girls attending public schools in the city of Akron.

The method of prevention used in that experiment consisted of the administration of 2 grams of sodium iodide in 0.2 gram doses distributed over a period of two weeks and repeated each autumn and spring. It was known that these amounts were excessive and far beyond the needs or ability of the organ to utilize, but it was necessary to provide a large factor of safety to avoid possible failure. This demonstration was carried out for a period of two and one-half years with the following results: Of 2190 pupils taking the 2 grams of sodium iodide twice yearly, only 5 developed thyroid enlargement, while of 2305 girls not taking the prophylactic, 495 developed goiter. Of 1182 girls with goiter at the first examination, who took the prophylactic treatment, the thyroid enlargement decreased in 773, while of 1049 pupils with thyroid enlargement on the first examination but who did not take the prophylactic treatment, 145 thyroids decreased in size. These figures demonstrate in a striking manner both the preventive and curative effects of minute doses of iodin. The result was just as striking as that previously obtained in animal experiments. Since these results were reported numerous reports confirming these observations have appeared in the European literature, particularly from Switzerland and Italy.

Iodin is effective when administered in any form and by any means.

This fact introduces difficulties and advantages, difficulties as regards the best form and means of administration, and advantages in that the desired results may be accomplished with certainty in a variety of ways. Historically and of course quite unknowingly, iodin containing salt was the first means of prevention and I am of the opinion that ultimately it will prove the best means of administration where the entire population is to be protected. The exclusive use of sea-salt or a salt containing 0.01 per cent iodin would seem ample for protection. If prevention is to be applied only to units of population, as for example school children or pregnant women, the Swiss plan of giving tablets containing 5 to 10 mgm. of iodin at weekly intervals is more convenient and quite sufficient for prevention. In some communities a salt of iodin is being added to the water supply after the manner of our experiments with the brook trout. This also is simple of application and effective but wasteful and of limited application.

Simple goiter develops most frequently during fetal life, during adolescence, and during pregnancy. Any plan of prevention that controls thyroid overgrowth during these three periods would eliminate over 90 per cent of goiter. Goiter in the mother and fetus can be prevented as easily and as simply as that of adolescence and by the same means. The dangers of untoward effects of iodin when used in the minimum amounts suggested are negligible. There is no doubt but that a great deal of harm has been and still is being done by the excessive use of iodin. Its abuse in the prevention as well as the treatment of goiter will continue until it is realized by the profession generally that the maximum storage capacity of the normal thyroid is around 25 mgm., and that such a storage is sufficient to meet the ordinary physiological needs of the organism for months.

The prevention of goiter means vastly more than eliminating cervical deformity. In some countries like Switzerland it may be called their national disease. Observers from the time of Pliny have noted the human inefficiency and wastage that this particular malnutrition causes. No one can estimate the misery and suffering this scourge directly and indirectly has caused throughout the ages because we do not yet know all the ways in which normal thyroid function influences nutrition. Enough is known to realize that goiter even in its milder forms modifies growth, physical and mental vigor, resistance and susceptibility to infections, and even certain forms of cancer, while in its severest form it causes cretinism, the care of which in some states is still a tax on the economic resources. The application of our present knowledge of prevention will eliminate these particular effects of thyroid insufficiency. Further, it would prevent the development of thyroid adenomata which are an integral and essential part of endemic goiter in man. Since fully 90 per cent of all thyroid carcinomata arise from these adenomata, it is obvious that an opportunity is offered of preventing a relatively minor though actually important cause of cancer.

In conclusion we have succeeded in showing one of the ways in which simple goiter may be controlled. Individual communities like Rochester, New York, with able and interested public health officers and even states, as for example Michigan under Commissioner Olin, have made some progress. It is one of the important public health problems yet one where success seems assured. The ultimate solution rests with adequately trained, full time, public health administrators rather than with practicing physicians.

RECENT ADVANCES IN INDUSTRIAL TOXICOLOGY IN THE UNITED STATES

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The important contributions to the field of industrial toxicology which have been made by Americans are for the most part fairly recent, and therefore a review of this field of medicine which covers the last fifteen years would include most of the really significant publications by American authors. This would not be true in any other country but our own, but the truth is that industrial medicine, long recognized as an important branch in the older industrial countries, was almost wholly neglected throughout the nineteenth century in the United States and the first important study of a poisonous trade did not appear till 1910 when John B. Andrews' (1) report on phosphorus poisoning in the manufacture of lucifer matches was published by the Federal Bureau of Labor. For the next five years a good deal of attention was paid to purely exploratory work of this same character, work which was necessary at that time in order to determine the actual incidence of industrial poisoning in the United States and the conditions in industry which underlay this incidence. Then came the war, and with it a sudden awakening of interest on the part of physiologists and pharmacologists in the problems of industrial health. From this period date a large number of studies, not only observational but experimental, which have done great credit to American medicine and which continue to appear. Fifteen years ago, at the Congress of Industrial Hygiene which was held in Brussels in 1910, the United States was in the mortifying position of a great unexplored country which had nothing to add to the knowledge of the world in this branch of medicine and had not even begun to learn about itself. This last September in Amsterdam at the meeting of a Congress on Industrial Accidents and Diseases our country was continually referred to as the one which had made the most important recent contributions to the literature of industrial poisons.

In any study of industrial toxicology, lead must always stand at the head for it is still the most widely used and still claims the largest number of victims. Lead poisoning had been known for centuries, but our modern knowledge concerning it dates from the epoch-making work of Tanquerel des Planches (2) which appeared in 1839 and was translated into English by Samuel Dane of Massachusetts in 1850. The literature of the last century abounds in studies of the clinical manifestations, the pathology and pathological physiology of lead poisoning, and yet up to very lately much remained obscure with regard to the actual mode of absorption of lead, its action on the blood, its fate in the body, the manner of its storage, and the influence of changes of metabolism on its excretion. We knew from practical observation, that much more rapid and severe poisoning followed the breathing of lead fumes and dust—practically the same thing—than the ingestion of lead from soiled fingers. Indeed that close observer, Tanquerel, had noted that it was only workmen who were habitually "in an atmosphere filled with lead particles or emanations" who were liable to lead encephalopathy but no satisfactory experimental study of these facts had been made. We knew that lead was carried by the blood stream and exerted a destructive action on the red blood corpuscles, as evidenced by anemia and by the appearance of stippled cells, but the exact nature of the latter was a matter of controversy. Instances of clinical plumbism seemed to show that lead might long remain latent in the human body and then under some obscure alteration of metabolism suddenly light up into activity and produce typical symptoms of poisoning, years after exposure to lead had ceased, but here too we lacked knowledge of the real basis of such phenomena. The treatment of acute plumbism with magnesium sulphate and of chronic plumbism with potassium iodide, had only an empirical basis.

The work done by Aub and his colleagues, Fairhall, Minot, and Reznikoff (3), at the Lead Institute of Harvard has added enormously to our understanding not only of the nature of lead poisoning but of its prevention and treatment. An important preliminary to these studies was the establishment of new methods for the detection and quantitative estimation of lead in biologic material, which was Fairhall's contribution. The results of the studies of the Lead Institute may be briefly summarized as follows: Lead which gains entrance to the body is converted after absorption to a colloidal phosphate which is very stable at the normal hydrogen ion concentration of the body but which passes into a more soluble form if the reaction is altered even slightly. It is not stored in the organs, although as it encounters the various soft tissues it reacts with them causing more or less damage, but it is not long retained in them, it is removed and carried on in the blood stream either to some site of excretion or to the skeleton, where it is deposited as the tertiary phosphate in the compact substance of the bones, not the marrow. Here it may remain latent for probably long periods unless a change in metabolism occurs, but under the influence of an acidosis this stored lead is mobilized and passes again into the circulation, again causing damage. Two practical points may be mentioned here; first, that the presence of lead in the skeleton proves lead absorption but not that lead was the cause of death, for so long as it is not in the blood stream it works no injury. On the other hand, if lead be present only in the gastro-intestinal tract there is no proof of absorption. The presence of lead in the urine, however, is evidence of either recent absorption or of mobilization of stored lead from the bones.

The routes by which lead compounds are absorbed are the respiratory and the gastro-intestinal, and the greater danger of the former route is shown in Minot's (4) experiments. It was possible to feed animals large quantities of lead with the production of only slight poisoning, while a much smaller dose administered by intratracheal insufflation produced quick and severe poisoning. In the former experiments the ingested lead must be absorbed from the intestinal tract and pass through the very efficient filter of the liver, a large part of it being returned to the intestinal tract through the bile. But in the second kind of experiments the lead can pass directly into the capillaries of the lungs, and the system is rapidly flooded with it.

Aub's experiments on excretion are not only of scientific interest but of decided practical importance. He found that there is an analogy between the metabolism of calcium and lead, and that measures which decalcify also release lead from the hard bone and cause it to appear in the urine and feces. The production of acidosis by administration of various acids has this effect, but since ammonium chloride causes less digestive disturbances this salt was the one finally adopted. In practical treatment it may be necessary temporarily to favor retention of the lead by means of a high calcium diet if the patient is suffering from severe acute symptoms, but for ordinary cases a low calcium diet, together with ammonium chloride, is prescribed and the favorable action is easily explained by the appearance of lead in urine and feces or by an increased excretion of lead. The old treatment with magnesium sulphate does not influence total lead excretion, it simply relieves constipation. Potassium iodide does increase it but not so efficiently as acidosis.

Another practical point which emerges from these studies concerns the well known interrelation between lead poisoning and caries of the teeth, for lead is deposited in the teeth as well as in the bones of the skeleton and may be an important factor in causing their decay. Cats under normal conditions always have perfect teeth, but develop rapid and marked caries when exposed to lead.

The action of lead on the blood consists in an alteration of the surface of the red blood cells, causing an impermeability to water which means a marked increase in their resistance to hemolysis. The leaded red blood cell is changed from an elastic distensible sac to one which is contracted, relatively inelastic and brittle, and therefore easily destroyed. Because of the loss of these cells there is a production of young cells, but these are affected by lead after they enter the circulation, their basophilic substance is coagulated or clumped. The so-called stippled red cell is therefore a young red cell damaged by the lead in the circulating blood.

Edinger's (5) theory of the localization of lead palsy according to the over-use of given muscles has been accepted and is confirmed by many clinical observations. Aub believes that the subject is still a matter for investigation because so far as is known only muscle becomes fatigued, not nerve, and experiments *in vitro* have demonstrated that lead does not interfere with the function of isolated nerve, whereas it does affect muscle markedly by changing the permeability of the surface of the muscle cells. He suggests that the physiological lesion of lead palsy is in the muscle itself and depends on the chemical reactions between lead and the metabolic products formed during muscular activity. Nevertheless it remains to be explained why lead palsy should be accompanied by lesions in the spinal cord and the peripheral nerves.

Two other recent studies on lead seem to me to be very illuminating. One is Blumgart's (6) discovery that white lead in fine dust can be absorbed from the nasal mucosa and lead poisoning produced even when the lower respiratory tract is shut off, another proof of the importance of lead dust and fumes in the causation of industrial plumbism. The other is an observation by Fine (7), which sheds light on the notorious and universal prevalence of pulmonary tuberculosis among printers, who are among the most intelligent and well paid wage earners and whose exposure to dust is of the slightest. Fine examined on the warm stage the phagocytic power of endothelial cells in contact with particles of carbon, of silica, of white lead and of atomized metallic lead. The particles of carbon were of course ingested with ease, those of silica with difficulty, as had been observed before, but to his surprise he found that the particles of metallic lead were taken up with much more difficulty than white lead and even than silica. The printer is throughout his working life exposed to minute quantities of metallic lead dust and the tuberculosis from which he suffers may perhaps be traced to this.

Of the other heavy metals, manganese is the one to the toxicology of which Americans have made the most important contributions. Up to 1912 all of the work on manganese poisoning had been done by Europeans. In that year Casamajor (8) described before the Fifteenth International Congress on Hygiene which was held in Washington, no less than nine cases of this curious form of paralysis and psychosis from one plant in New Jersey, making a larger number than had been observed up to that time in Europe. In 1919 Edsall and Drinker (9) published their study of manganese poisoning, one of those studies which really covers the field in such a way as to make subsequent observations simply supplementary to it. This brought the number of American cases up to 39, while Europe had had only 15. These authors show that the inhalation of dust is the important cause of poisoning, that manganese is absorbed directly from the lungs but also from the gastro-intestinal tract because much of the dust is swallowed. The shortest period of exposure in their cases was a month and a half, and the earliest symptoms appearing at that time are sufficient to give warning in time for removal from exposure and the prevention of further progress of the disease. The symptoms are suggestive of changes in the lenticular nucleus, but so far no detailed pathological study has been made of a human case, for though manganese poisoning produces incurable crippling, it does not kill. Hugo Mella (10) of Boston succeeded in producing in three monkeys, by intraperitoneal injections of manganese chloride every other day for eighteen months, marked disturbances of motility and pathological changes in the lenticular nucleus. Further experiments with manganese by C. K. and K. R. Drinker, together with L. A. Shaw (11), have thrown interesting light on the function of the liver and especially of the Küpfer cells in removing insoluble particles from the blood. Manganese dioxide injected into the venous system of cats was found deposited chiefly in the liver, lungs, and spleen, but that in the lungs diminished rapidly while the amount in the liver increased, in other words there was a gradual transfer of manganese from the lungs to the liver, and excretion from the latter by way of the bile. The greater part of the manganese dioxide was within the Küpfer cells which were evidently the most effective agents in removing it from the circulation.

Tellurium is as yet of slight importance in industry but some American contributions concerning it have already appeared. Mead and Gies (12) have studied it experimentally, and Shie and Deeds (13) of the United States Public Health Service have studied its occurrence in industry and the symptoms caused by mild poisoning. It is probable that tellurium will increase in importance in the near future, and these observations will then be of great value.

During the war studies were made in all the belligerent countries of the explosives belonging to the nitro and amido derivatives of the benzene ring, but the American contributions in this field were not nearly so important as the German, French, and British. Our best work was done not in the effort to protect our munition workers but in the investigation of gases to be used in chemical warfare, and the work which deserves special mention in a paper on industrial poisons is that of Winternitz (14) and his colleagues on hydrogen arsenide and phosgene. Hydrogen arsenide poisoning in industry is a neglected field in the United States because we still suffer from lack of accurate study of individual instances of industrial poisoning. Our state labor departments and health departments are not equipped to carry on such studies, and cases of poisoning from industrial gases, even when fatal, are often reported simply as "acid fume poisoning" without any attempt to discover the nature of the fatal gas. When you consider that hydrogen arsenide may be evolved whenever a metal carrying arsenic as an impurity comes in contact with a heavy acid[1] and when you consider that practically all the ordinary lead, zinc, and antimony of industry and much of the iron is so contaminated, you can see how great an opportunity there is for this form of poisoning to occur. Metals and acids are brought together in pickling metals for plating, in wire drawing, in the making of storage batteries, when acids are kept in lead lined tanks, and in many other processes. Moreover, if the metal is free from arsenic the acid may be contaminated unless it has been made by an expensive process.

Phosgene is used in the making of anilin dyes, but its importance in industry depends on the fact, demonstrated by Fieldner and Katz (15) of the Bureau of Mines, that the use of carbon tetrachloride fire extinguishers in enclosed places with an insufficient air supply results in the production of carbon monoxide and phosgene, $COCl_2$, instead of carbon dioxide. This reaction has led to several industrial accidents with fatal outcome.

But after lead, it is in the field of the organic compounds that the greatest recent contributions have been made by Americans.

Carbon disulphide is still an important industrial poison, for although it is less used than formerly in the vulcanization of rubber goods it is still required for very thin rubber articles which must be vulcanized in the cold and it is an important ingredient in that growing industry, the manufacture of artificial silk, by the "Viscose Process," where it is used to change the alkali-cellulose produced from wood pulp to cellulose xanthate, a stage in the production of pure cellulose. The paralyses and psychoses caused by carbon disulphide have been carefully studied by several Americans, notably Peterson (16) who saw three cases of carbon disulphide insanity from a rubber factory of New York State; Heath (17) of Indianapolis who saw optic nerve blindness in a rubber worker; Jump and Cruice (18) of Philadelphia who saw two cases of insanity from an artificial silk works; and Francine (19) who saw one case from the same factory.

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[1] Sulphuric acid and hydrochloric, not nitric.

The recent studies made in the United States of that very important industrial poison, carbon monoxide, have added a great deal to our knowledge. Yandell Henderson and H. W. Haggard (20), and their colleagues have made precise estimations of the effect of different concentrations of the gas in connection with the problem of ventilation in the Hudson River vehicular tunnels where the exhaust gases from motor cars will complicate the situation. In the course of their investigation they found important differences between pure carbon monoxide and mixtures, such as illuminating gas. Unfortunately, as anyone can see who examines the literature of gas poisoning, the two are often confused or assumed to be identical. Very interesting in this connection is Haggard's (21) discovery that he could grow neuroblasts in vitro in a concentration of carbon monoxide as high as 79 per cent, but that illuminating gas was quickly toxic in a concentration of 0.1 per cent. From the experiments of Staehelin of London it seems more than probable that the compound in illuminating gas responsible for this effect is benzene, and Henderson and Haggard found that exhaust gases from engines using a benzene-gasolene mixture were more rapidly toxic to dogs than the gases from engines using gasolene. In the former case death would come in dogs at a point when the blood showed only 62 per cent of carbon monoxide saturation, while in the latter case the animals did not die till their blood was 83 per cent saturated.

Poelchen (22) in 1882 first announced the post mortem finding in cases of illuminating gas poisoning of yellow softening, often symmetrical, in the lenticular nucleus of the corpus striatum and this was confirmed by several Germans during the following twenty years, but contested by others. The strongest confirmation of Poelchen's statement is found in a paper published in 1918 by Hill and Semerak (23) of Chicago who were able to examine, fresh from the autopsy table, 32 brains of victims of fatal illuminating gas poisoning. In 14 of these, bilateral softening of the lenticular nucleus was visible to the naked eye; in the other 18, which showed no gross abnormality, microscopic areas of necrosis were found in this region. The damage varied from slight perivascular lesions in the globus pallidus to grossly visible softening of the whole lenticular nucleus and internal capsule, its extent depending on the age of the patient, pre-existing vascular lesions, the amount of gas inhaled, and the duration of life after gassing. The localization is explained by anatomic peculiarities in the circulation of the lenticular nucleus.

The sequelae of carbon monoxide poisoning have not been studied so carefully in connection with industrial accidents as those following poisoning in private garages or from illuminating gas. Toxic blindness following acute gassing from the CO produced by the explosion of dynamite has been described by Brose (24), and paralysis with atrophy by Krauss (25), although there is some uncertainty here as to the part played by gasolene fumes. Apfelbach (26) of Chicago, and Egdahl (27) of North Dakota have described the blood changes in exposure to chronic carbon monoxide poisoning, a polycythemia with slight eosinophilia which in some cases is accompanied by a low percentage of hemoglobin.

When we enter the field of the coal-tar and the petroleum solvents we find a large number of volatile poisons some of which are new in American industry, having been produced in this country only since the outbreak of the war and the shutting off of the supply of German chemicals. These solvents, which were formerly expensive and comparatively little used, are now produced in the United States and finding increasing use. We still must turn to German literature for most of our information concerning them and even the Germans do not always tell us all that we need to know about their toxicology, nor can we assume that our industrial methods are exactly the same as theirs. Here is a field in which there is urgent need for research, and it would take a large number of workers to keep up with the continual introduction of new compounds. Recently in my mail I have had inquiries from manufacturers and insurance companies with regard to the symptoms caused by and the way to protect workers against the following compounds: of the petroleum series, acetone, acetaldehyde, formaldehyde, acrolein, amyl alcohol, butyl alcohol, methyl alcohol (with regard to toxic quantity and to unusual symptoms), amyl acetate, methyl acetate, butyl acetate, sulphuric ether (chronic poisoning), carbon tetrachloride, trichlorethylene (fatal case), methyl chloride, methyl bromide, formic acid, nitroglycerine (making tablets in a drug supply house), and lubricating oils; from the coal-tar series, benzene (more inquiries about this than about any other one compound), anthracene, naphthalene, phenanthrene, carbazol, nitrosocarbazol, phenol, picric acid, toluene, trinitrotoluene, monodichlorbenzene, ortho- and paradichlorbenzene, paraphenylenediamine, phenyl hydrazin, diphenylguanadin, and other guanidins, hexamethylenetetramine. In all these letters I am informed that the compound in question has been introduced into manufacture recently, and the producer or user is anxious to know everything about the toxic action and how to protect workers against the effects. Of course there are many of these compounds which are fairly thoroughly understood, but with regard to others I am obliged to answer that I can only tell them what will probably be the mode of entrance and the action of the given poison judging from bodies of similar chemical composition. In addition to these, my correspondence now has to do also with that interesting poison, tetraethyl lead, and that very new industrial poison, radium, which in the form of various radio-active salts is beginning to cause more or less trouble.

Back in 1914, when this great change began, it would have been difficult to say which of the new compounds was causing the most trouble. Anilin was at that time used very widely as an accelerator of vulcanization of rubber, and when the German supply failed we were obliged to start producing it ourselves. As anilin is amido benzene it was necessary to recover benzene from the coke ovens to meet this demand and also the demand for the production of synthetic phenol, hydroxybenzene. Three years later, when we entered the war, toluene for the production of trinitrotoluene became enormously important, and phenol was needed for picric acid and ammonium picrate. Methyl alcohol was continuing to cause blindness and death in industrial workers and the producers of this solvent had not yet been brought to the point of admitting its toxicity in industry, that is of admitting that poisoning could occur through the inhalation of fumes.

Trinitrotoluene is now fortunately almost negligible as an industrial poison. Anilin has given place in the rubber industry to the less toxic organic accelerators, such as the guanidins and hexamethylenetetramine. Methyl alcohol is still a distinct danger because of its continued use as a solvent for shellac, but its dangerous properties are now so universally recognized that it is usually possible to insist on the substitution of denatured alcohol in any plant in which its use is causing illness. Methyl alcohol was pre-eminently an American industrial poison up to 1906 when at last it became lawful for manufacturers to use denatured grain alcohol, and even now American industry uses pure methyl alcohol more than does any other. It is natural therefore that there should be many American contributions to this chapter of toxicology. I need only mention the contributions made by Casey Wood (28) of Chicago with his assistants, and with Buller (29) of Montreal, on the blindness caused by methyl alcohol; the contributions to the pathology of methyl alcohol blindness made by de Schweinitz (30), by Holden (31), and by Friedenwald (32); the experiments of Reid Hunt (33) on the action of pure and of crude methyl alcohol which showed the fallacy of the claim that it is the impurities that do the damage; and in more recent years the work of Tyson and Schoenberg (34) who, experimenting with rabbits, guinea pigs, dogs, and one monkey, produced typical changes in the optic nerve by inhalation alone. The latest American contribution to the pathology of this form of poisoning was made by Ziegler (35) in 1921. He believes that the primary and fundamental lesion in all cases of methyl alcohol poisoning is a profound injury to the pituitary body. "The changing but steadily contracting visual fields, the fugitive scotomas, the visual loss and recovery, the sclerotic or atrophic nerve heads, the fixed and dilated pupils, the temporary paresis of the extra-ocular muscles, the ptosis, the ataxic gait, and the mental hebetude, are all characteristic of pituitary involvement."

The United States is one of the greatest producers of petroleum and the distillates, light and heavy, find an enormous use in industry. Yet it remained for a German toxicologist, Lewin (36) of Berlin, to write the first article on poisoning in American oil fields in 1888. Many years passed before any American contributions of importance appeared, but during the last eight years we have done better. The very troublesome occupational disease known as oil folliculitis or furunculosis has been brought under control, chiefly as the result of two American studies. Marvin Shie (37) in 1917 showed that cutting oils in machine shops harbored large numbers of staphyloccocus aureus and that the same organism could be cultivated from the infected wounds of the machinists. The next step was taken by the Research Staff of E. F. Houghton and Company, Philadelphia, who found that while all cutting oils have the power of penetrating the skin, especially hairy skin, and carrying in bacteria, there are certain ones which are especially harmful because they favor the growth of these bacteria more than others. This is especially true of the so-called paraffin oils obtained by pressing solid paraffin. Prevention, therefore, depends on proper selection of the lubricating oil and strict bodily cleanliness of the operative. So far the United States has escaped the much more serious skin diseases caused by coal-tar oils and pitch and paraffin which in the artificial fuel industry on the continent, and still more in Great Britain, give rise to the so-called "tar cancer," now the greatest single drain on the workmen's compensation funds in England. I do not wish to leave the consideration of petroleum without mentioning the work of the Bureau of Mines on gasolene vapor and the protection against it (Fieldner, Katz, and Kinney (38), and the case of severe chronic naphtha poisoning described by R. L. Haden (39) of the Johns Hopkins, one of the most interesting cases in the literature.

Among the industrial poisons the knowledge of which was extended during the war, mention may be made of sulphuric ether and of tetrachlorethane. Ether is used in great quantities in smokeless powder manufacture, and during the war women were employed in the work that involved the greatest exposure to fumes. The blood changes in a group of 51 women were studied by G. R. Minot (40). Unfortunately his investigation was cut short by the dismissal of the women after the armistice and he was only able to establish the fact of a marked polycythemia, in these ether workers, the red cell count running from 5,500,000 to 7,800,000. Only six had less than 5,500,000, and seven were up to or over 7,000,000. The white counts averaged 11,000.

Tetrachlorethane is a much more toxic compound and is more important as an industrial poison both in war and in peace. At the outbreak of the war Germany had already abandoned its use as a solvent for cellulose acetate in airplane dope because of the discovery of severe and sometimes fatal toxic jaundice which developed in in several factories. The British made the same discovery in October, 1914, and from then till January, 1917, when a substitute solvent was found, there were 70 known cases of toxic jaundice with 12 deaths. The use of tetrachlorethane in industry is rather a mystery at present and no one can say how wide it is nor how much damage it has produced. It is much the best solvent for cellulose acetate, and cellulose acetate is used for the production of non-inflammable photograph films and coatings of all kinds.

The fact that an artificial silk factory near Boston is under unusually conscientious management made it possible for G. R. Minot together with L. W. Smith (41) and D. C. Parmenter (42) to study the effect of slight exposure to tetrachlorethane fumes on the physical condition of workers and to determine the changes which could be relied upon as a warning of danger.[2] They found that, even when the symptoms are very vague and indefinite, a distinct and important change is found in the blood, consisting of an increase of large mononuclear white cells, probably endothelial, with a corresponding fall in polymorphonuclear cells and lymphocytes. If these cells reach 20 per cent of the white count, poisoning is indicated, and if many of them are broken, damaged, the indication is that the poison is progressing rapidly. Parmenter (42) has found that periodical examination of the blood of workers makes it possible to detect poisoning in its early stage and ward off any serious accident.

Among the coal-tar derivatives which have come into importance of late is paraphenylendiamine, used as an accelerator of vulcanization in rubber manufacture and as a dye for fur and felt. Knowles (43) in 1916 showed that this body as used by furriers has not only the notorious property of setting up a dermatitis but is capable of producing systemic poisoning, sometimes of a severe character. Olson

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[2] This is the "Lustron" process of manufacture, differing from the "Viscose" which uses carbon disulphide.

(44) that same year, described attacks of bronchial asthma in furriers which he regarded as anaphylactic in character, but Hanzlik (45), who has made an exhaustive study of the pharmacology of the phenylenediamines, rejects this explanation and believes the bronchitis and asthma caused by paraphenylendiamine to be due to direct irritation of the lining of the bronchial tubes since he finds that these diamines produce in animals edema of the face, nose, neck, and conjunctiva.

The most important post-war change in industry to my mind is the enormously increased use of benzene as a solvent for fats, gums and resins. It used to be expensive, since it had to be imported from Germany, and the solvents ordinarily used were the low-boiling distillates of petroleum, relatively harmless. But when after the war the new coke by-products plants continued to produce benzene and it was no longer needed for explosives, the price fell and benzene was soon displacing naphtha, for it is a more powerful solvent and evaporates more rapidly, an advantage to the manufacturer, an increased peril to the worker. During these years since the war benzene has not only maintained its important place but has greatly increased it. It is now, in my opinion, the most dangerous industrial poison because of its increasing use and because of the difficulty in safeguarding the workers against its effects. It is not acute benzene poisoning that we fear; that can be prevented by modern engineering methods and an accident resulting in severe acute poisoning is now rightly regarded as a disgrace, which may be confessed in confidence, but which is not published abroad if it is possible to avoid it.

With chronic benzene poisoning, however, the case is very different. Here is a problem which instead of growing simpler year by year increases in difficulty so that industrialists and insurance men are just now more impressed with the dangers attending the use of benzene than they ever were before. The significant American work on benzene began with the famous cases here in the Johns Hopkins Hospital described by Lawrence Selling (46) who later confirmed his findings by animal experiments. They were not the first instances of purpura hemorrhagica in young girls exposed to benzene, for Santesson (47) of Sweden had already described twelve, but Selling's work was much more thorough and it was he who first showed that the characteristic feature of chronic benzene poisoning is not the purpura or even the anemia but the profound leucopenia, and the autopsies in his cases made by W. H. MacCallum and by M. C. Winternitz revealed changes characteristic of aplastic anemia in the blood-forming tissues. Since then, a number of careful clinical reports of cases of chronic benzene poisoning have appeared in American journals[3] but more interesting and important is the work done on the pathology of benzene poisoning, beginning with Selling's (53) experiments. He showed that benzene is a powerful leucotoxin destroying the white cells of the circulating blood and the parenchymal cells of the blood-forming organs—bone marrow, spleen, lymphatic glands, and the lymph follicles in the appendix—the myeloid tissue suffering most. The action on the specific cells of the bone marrow is two-fold, irritant as well as destructive, and for a while the two actions go on simultaneously, and if the administration of benzene is stopped, regenerative changes begin fairly promptly.

Weiskotten (54) and his colleagues were interested only in the therapeutic use of benzene, not its use in industry, but nevertheless their experiments have a decided bearing on the latter. They found that the same lesions can be brought about in animals by administering benzene in vapor form as by subcutaneous injection. It is also significant that Weiskotten found both a primary and a secondary rise in the leucocyte count as the temporary result of even a single dose of benzene, and that in the presence of active acute infection the usual polymorphonuclear leucopenia did not appear, in fact there was a typical polynucleosis which persisted till death. These are important points to remember in connection with industrial cases where it is often assumed that leucopenia is the only positive diagnostic sign of benzene poisoning.

The experiments of Duke (55) had to do with the hemorrhagic features of benzene poisoning, with the prolonged bleeding time. He found that injections of benzene cause first a rapid rise in the platelet count followed by a rapid fall. A little later Hurwitz and Drinker (56), following up the work of Selling and of Duke, produced in rabbits not only a marked reduction of all the formed elements of the blood but also of the circulating prothrombin. Hektoen (57), noting that benzene appeared to show a selective action on those tissues and cells that are concerned in the production of antibodies and in defence against infection, tested the influence of benzene injections on the blood of animals and found that there is actually a lowered resistance to infection, as shown by a depression of antibody formation, and a reduction not only in leucocyte formation but in the phagocytic power of the leucocytes. Rusk (58) of California also found that animals poisoned with benzene produced hemolysins and precipitins much less efficiently than normal animals. These experiments confirm the observation of Weiskotten noted above.

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[3] See McClure (48), Hogan and Schrader (49), Harrington (50), Newton (51), and Starr (52).

The attention of the industrial world was turned toward the benzene problem in the fall of 1922 when at a meeting of the National Safety Council, an organization of employers and of industrial insurance companies, a representative of an insurance company urged on the Council the necessity for greater precautions in the use of benzene as a solvent and succeeded in having a committee appointed to study and report on the question. The Committee consists of three men connected with industries using benzene, an insurance man, a representative of the manufacturing chemists, together with Fieldner of the Bureau of Mines, Greenburg of the Public Health Service, Winslow of Yale, and Brady of the Massachusetts General Hospital (59). Their first report was simply on a general survey; it stated that 84 firms using benzene had reported 15 deaths from benzene poisoning and 83 non-fatal cases, it described certain desirable precautionary measures and asked time for more study. The second report was more serious. The Committee had made detailed studies of the benzene content of the air of 14 factories and had found that an efficient system of local exhaust ventilation would keep the benzene down to less than 200 parts per million, a quantity which did not seem to give rise to clinical cases of poisoning, so that apparently the use of benzene in industry might be made free from serious danger to the worker. However, blood counts showed leucopenia in 13 workers in whom benzene poisoning had not been suspected, so that it was possible that there might be a considerable amount of mild undetected poisoning. The third report, which has just appeared, goes much further and includes laboratory studies on the higher homologues of the benzene series, in the search for a less toxic substitute. The conclusions arrived at in this final report are much less favorable to benzene as used in industry than the investigators expected. In such industries as the manufacture of rubber goods, of artificial leather, of sanitary cans, in dry cleaning, and in the use of paints, varnishes, and removers, it is pointed out that the evaporation of benzene is a necessary part of the process and the principle cause of chronic benzene poisoning. The question is whether any system of ventilation can be depended on to reduce these fumes to a safe level. Blood counts made on individual workers showed that the danger from the use of benzene is not entirely removed even with exhaust ventilation which reduces the concentration of benzene to less than 200 parts per million in the air, and ventilation of this degree of excellence is rare. The Committee therefore recommends the substitution whenever possible of a less poisonous solvent and where this can not be done, the installation of the best possible exhaust system and regular monthly medical examination of the workers, including a white cell count.

The Committee's experiments with toluene and xylene are of decided value, for there is a good deal of confusion in the foreign literature with regard to the comparative toxicity of benzene and toluene. Hektoen found that the effect of toluene on antibody output is slight in comparison with that of benzene and the effect on the white blood cells is quite absent. The National Safety Council's Committee tested the effect of subcutaneous injections of benzene, toluene and xylene in doses of 1 cc. per kilogram body weight, mixed with an equal quantity of olive oil. The benzene animals showed obvious weakness and emaciation which was not shown by any of the others, also a typical leucopenia of severe type, and a reduction in the red cell count, while no change was found in the white blood count in the others, and only a slight lowering of the red cells. As a result, the Committee urges manufacturers now using benzene to give serious attention to the possibility of substituting one of these relatively harmless solvents. This report, coming as it does from men closely connected with industry, marks a great step forward in the control of this important occupational poison.

About 18 months ago rumors began to reach us of a curious new occupational disease among women employed in a radiolite watch and clock works, applying luminous paint to the dials. They were said to suffer from necrosis of the jaw quite like the phossy jaw of match workers, so common in the old days when white phosphorus was used in that industry. In several instances, just how many no one knew, death was said to have followed after a lingering illness which suggested the chronic sepsis of the victims of phossy jaw. F. L. Hoffman (60) formerly of the Prudential Life Insurance Company, now of the Babcock Institute, presented a paper on this subject at the 1925 meeting of the American Medical Association dealing with the histories of twelve cases, four of which were fatal and one was at the time in a condition of far advanced pernicious anemia with a red cell count of 1,180,000, 25 per cent hemoglobin, and no nucleated red cells. At the time of publication of his paper this woman was still living, but a fifth death had occurred from pernicious anemia, the victim being a woman whose case had progressed with unusual rapidity.[4] Hoffman lays great stress on the fact that up to a year or so ago the women put the little paint brushes in their mouths to point them, the luminous material consisting of zinc sulphide combined with radium and mesothorium. He quotes Sochoky, a radium technician of New York, who attributes the necrosis of the jaw to the joint effect of the weakly penetrative alpha rays of the radium acting locally and producing, together with the chemically irritating zinc sulphide, changes in the mucous membrane of the mouth which, while not necrotic or vesicant as would be the action of the beta and gamma radiations, would still be sufficient to lower the resistance of the mucous membrane to infection. The action of the beta and gamma rays are ruled out by Sochoky because the amount reaching the mouth on the paint brush is too minute.

A much more thorough study of this situation has recently been published in the Journal of Industrial Hygiene by a group from the Harvard School of Public Health, W. B. Castle and K. R. and C. K. Drinker (61), who examined not only the victims of poisoning but the women still at work in the factory and the conditions under which they were employed. They found not only necrosis of the jaw but blood changes. The necrosis is not at all like the ordinary infections of the jaw which sometimes follow the extraction of a tooth but which remain localized and eventually heal; it is a chronic progressive rotting away of the bone resembling very closely the form found in phosphorus poisoning. The blood changes consist in anemia together with a decrease of the white cell count especially the polymorphonuclears. Twenty-two persons examined in the factory and supposedly in good health showed blood counts varying from the normal, not one was entirely normal.

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[4] Later, the chemist employed by the company, died.

This effect on the blood has been described during recent years as occurring after treatment with x-ray or with radium, and also in workers exposed to these radiations. The effect on the white cells is greater than that on the red cells. An investigation was carried on by R. C. Williams (62) of the Public Health Service to determine whether persons engaged in measuring radium preparations in the United States Bureau of Standards were suffering any effect from the slight continuous exposure to the rays from radium compounds, chiefly the bromide. Pfahler (63) has established the fact that if sealed dental films become foggy within two weeks it is evidence of over-exposure to radiations, and Williams found that such films affixed to the foreheads of six of his workers all became fogged within a shorter period than that. He found that these people showed a tendency to a low white cell count involving especially the polynuclears and small lymphocytes, while the large mononuclears ran somewhat higher than normal. The red cell count was also diminished and a low blood pressure was common.

The blood changes in the workers in the watch factory were, therefore, of a character similar to what has already been observed in people exposed to x-rays or radium, but the necrosis of the jaw was much harder to explain. All other sources of toxic action were excluded and in the absence of any other possible source for this necrotic process the Harvard group were forced to conclude that the radium was at fault. Examination of the factory showed that the air of the workroom contained luminous dust, the hair, faces, hands, arms, necks, clothing and underclothing and even the bodies of the dial painters were luminous. Sealed dental films placed in various places in the painting room were distinctly fogged at the end of two or three days. All this showed excessive exposure to radiation, and in view of the descriptions in the literature of the effect of radium on bone—delaying or preventing the union of a fracture, disturbing the growth of bone, producing in a sound jaw a necrosis of bone in the course of radium treatment for cancer of the tongue—they conclude that the necrosis of the jaw in the dial painters was in some way caused by absorption of the radium, probably through the inspired dust. No other American factory doing similar work has, apparently, had any cases of necrosis of the jaw, and blood counts made in two, by Flinn of Columbia, failed to show characteristic changes. The British and the Swiss have searched their sickness insurance records for instances of necrosis of the jaw in non-phosphorus-using industries, but have found none, so that at present this remains an isolated incident.

Still another new industrial poison has attracted much attention in this country and so far nowhere else except in Switzerland, namely tetraethyl lead. It came into prominence about a year ago when the daily papers carried the story of a large number of workmen who had been poisoned by this strange new compound in the Standard Oil Company's plant in Bayway, New Jersey. The illness described resembled the severe form of delirium tremens, and five of the men died in great agony, so that the whole occurrence was dramatic enough to cause widespread interest and a demand for a public investigation of the dangers involved in producing the compound and in using the mixture of tetraethyl lead and gasolene for motor fuel. So far as can be ascertained there were five deaths and one case of insanity in the Bayway plant, twenty-eight cases with eight deaths at the Du Pont Company's plant at Carney's Point, and two deaths in Dayton, Ohio, in the plant of the General Motors Company, but these figures are not accurate for a good deal of secrecy has always been maintained with regard to the actual number poisoned.

The toxicology of tetraethyl lead was studied by W. A. Eldridge (64) of the Chemical Warfare Service. From experiments on animals he found that tetraethyl lead can be absorbed through the skin and through the respiratory tract and that it is possible to produce a cumulative effect with repeated sublethal doses. The symptoms consist in acute lead colic followed by diarrhea, the abdomen tense and painful to pressure, then nervous depression, tremors, weakness of the legs, coma, convulsions, and death. The cumulative action was tested on dogs by inunction and on mice by inhalation. The latter died on the fourteenth to the twentieth day, after breathing 0.5 cm. per liter of air for ten minutes daily. Lead was found in the urine and feces and in the skeleton, intestines, liver, and lungs, the largest amount being in the skeleton. Eldridge comments as follows: "We are dealing with a highly lipoid-soluble lead compound which is capable of skin penetration and which, furthermore, is comparatively stable. It is probably the only compound which absorbed through the skin causes acute lead poisoning."

Eldridge also summarizes the symptoms shown in the Standard Oil cases as reported to the Company by W. Gilman Thompson and A. W. Schoenleber, May 16, 1924. The first symptom noticed is a marked fall in blood pressure, sometimes as great as 60 mm. of mercury, with an accompanying fall in body temperature, sometimes as low as 94.6°F., and a low pulse rate, down to 48 a minute. Then symptoms of profound cerebral involvement appear, obstinate insomnia, marked restlessness and desire to talk, and then delusions especially of sight. The gait is distinctly ataxic, and soon exaggerated movements of all the muscles of the body begin, but there are no true convulsions. The patient becomes violently maniacal, shouting, leaping from the bed, smashing furniture, and morphine only accentuates the symptoms. Death may come from exhaustion. In two cases the body temperature rose to 110°F. just before death. Changes in the red blood corpuscles are marked, and in one fatal case the blood failed to coagulate and had the color typical of carbon monoxide hemoglobin. The fall in blood pressure may be very rapid; in one case the systolic blood pressure dropped from 190 to 112 mm. of mercury in three hours and a half.

In less severe cases, as shown by twenty-eight histories reported to Eldridge by the Du Pont Company's physicians, the most common finding is insomnia, then follow a low blood pressure and a subnormal temperature. Loss of appetite, nausea, abdominal cramps, a sense of weakness, bad dreams, vertigo, headache, morning vomiting, and a decided loss of weight, together with a metallic taste in the mouth and muscular tremors, suggest the picture of chronic lead poisoning in which neuro-muscular symptoms predominate. In four cases there was a lead line on the gums.

The danger involved in the production of tetraethyl lead and the process of mixing it with gasolene is therefore abundantly proved, and measures have accordingly been taken to safeguard so far as possible these classes of industrial workers. The further problem, the possibility of danger to garage employees and even to the public from the use as motor fuel of gasolene to which tetraethyl lead has been added, has been referred to a committee of experts appointed by Surgeon-General Cumming of the Public Health Service whose findings we hope to learn at the beginning of the coming year. Dr. Howell is chairman of that committee.

It may be that within a very short time anyone who speaks on the subject of the poisonous trades will feel obliged to include the stone-cutters, that is the cutters of granite and sandstone, the copper miners of Montana, and the zinc miners of Missouri, workers in potteries and tile factories, sand-blasters, and all others who are exposed to silica-containing dusts. This is because the latest researches in Great Britain and in the United States seem to show that the action of silica particles in the lungs is not of a physical, mechanical character, but rather of a chemical and therefore toxic character. At the present moment, however, this point of view is not accepted by the Germans nor by the Dutch or the Scandinavians, and since it is still in the field of controversy it is better not to include silica in a discussion of the industrial poisons.

I think you will see what rich mines of interesting research are still waiting to be explored by the industrial toxicologist and it is to be hoped that the next ten years will see as much advance on the part of American investigators as the last ten years have seen.

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THE NECESSITY OF EDUCATION IN THE CONTROL OF CANCER

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By "the control of cancer" is meant the reduction in any possible way of the present high death rate from cancer. That, in the United States, amounts to nearly 90 per 100,000 of the population, a figure that is probably nearly 25 per cent too low, because of the lack of correct diagnoses on death certificates. The true rate is presumably nearer 120 per 100,000, for Switzerland's rate is about 125 and in that country is based largely upon autopsy figures. Allowing for the difference in age distribution, this would make the United States rate 110 to 115 per 100,000. These figures mean that of all deaths between the ages of 45 and 65 about 1 man in 13 and 1 woman in 8 dies of cancer. The yearly individual death rate from cancer, that is, the probability of any person aged 50 dying of cancer during the year, is of course very much less. No accurate figures are available, but for men this is approximately 1 in 1000 at that age and for women 1 in 800, the probability of death from cancer increasing with age until in the higher age groups, say 85 or 90, it approximates 1 chance in 100 that a person will die of cancer during the year. In these higher groups cancer ranks as one of the three important causes of death.

Despite all improvements in surgery, no change has taken place in the recorded death rate. Instead, it is slowly increasing in this country. Evidently it is imperative to take any possible means to check this high mortality.

When we speak of cancer, we mean any type of malignant tumor. Of these the most important are carcinoma and sarcoma, of which the first causes about 90 per cent of the deaths from malignant tumors, and the second about 10 per cent.

Cancer differs from all other diseases in that its occurrence seems not to depend in any essential way upon variations in general health, but is correlated rather with sex, age, and race factors, plus an irritative element of unknown effectiveness derived from certain social and hygienic habits. Sex distribution is shown in the frequency of cancer of the uterus and breast in women and of the oral cavity and stomach in males. Increasing age, as has been said, is directly correlated with the frequency of cancer. Race plays a part still difficult to evaluate, and comparable statistics are not available, but the negro is less liable to cancer of the skin than the white, and certain of the East Indian tribes seem to have less cancer of the stomach than the white races. But it must be granted that very few of the published cancer statistics have any great accuracy because of the difficulties of diagnosis and the imperfect birth and population records which lie at the bottom of all such statistics. Whether the disease is increasing or not is still a much debated point. There is no question that in most countries the recorded rate is increasing, but in those which have the highest death rate, such as Denmark and Switzerland in which the diagnoses are most accurately made, there has been but little change in the rate in recent years. It is probable, therefore, that the rate in these two countries represents the highest for a mixed population living under modern hygienic conditions.

The social and hygienic habits referred to may be illustrated by the production of large numbers of cancers by certain practices: for example, the kangri basket cancer in which a burn is produced on the chest or the abdomen of the individual upon which cancer afterwards develops. The betel nut cancer in those who chew betel nut and retain the material in the cheek for long periods is also a well studied variety, and of the causal relationships of these two practices and cancer there can be no doubt. Shale oil and tar cancer is an important industrial type and recently an increasing number of such neoplasms have been noted in garage mechanics. Hygienic habits are illustrated in cancer of the tongue, which almost always occurs in males, preponderantly those with syphilis, and almost entirely in those whose mouth hygiene is rudimentary. Women rarely have cancer of the tongue, but even the most rabid geneticist has not yet suggested that cancer of the tongue is a sex-linked condition.

The part which heredity plays in the production of cancer in the human being is still undetermined. It is well known that there are families in which a large number of individuals die of cancer, and there are other families in which cancer is extremely rare. That heredity plays a part is unquestioned, and it may influence certain types more than others; or, to reverse the statement, irritation may be more important in the production of certain types of cancer than is heredity. The random distribution of the disease throughout a large population and the rarity of heavily cancered families would point rather to the fact that in the human being irritation plays an important part. Animal experiments have not yet cast a great deal of light upon the subject, and individual workers in the field are still far from agreement as to the facts. Until, therefore, there is more published in reference to human material, it is impossible to evaluate the relative importance of heredity and external influences in the production of human cancer.

That cancer is due to some type of germ has been suggested by a number of workers, the most recent in the field being Gye and Barnard. But the proof of the hypothesis is still far from being complete even in their hands, competent bacteriologists holding that the phenomena described can be equally well explained on a serological basis.

In contrast to most other diseases, especially those of an infectious origin, cancer is individual The person bearing a cancer is in no way dangerous to the other members of the community. The disease, so far as is known, is not in any way a contagious or communicable one. Even the victims' families are not touched, except in the cost of caring for the patient. The possible transmission of a susceptibility to the disease has been accomplished with the transfer of the germ cells and the fertilization of the ovum, and nothing can be done to free the individual from this taint. It passes on through the race, even though the person responsible for such transmission never develops cancer.

The object of cancer control is, then, to save from suffering and death a vast number of persons in active middle life, with two collateral aspects: the prevention of loss to the community of valuable intellectual and physical abilities, and to the relatives or the State the cost of invalidism.

What are the reasons for the necessity of education in the control of cancer? One of the most important of these reasons is the nature of the disease. Cancer, as has been said, is a portion of the individual's own body, which, for unknown reasons, gains the capacity to grow independently of the ordinary histological restraints. Such restraints limit in some way as yet unknown the growth of normal tissues and of reparative processes. Thus, for example, the organs grow with the developing child until adult life, and then stop, the only changes afterwards being reparative. True, the secretion of certain glands, such as the pituitary, may exert influences, so that if this particular gland is altered by disease, the bones, the connective tissues, and some of the organs grow to a certain extent beyond the normal. The process is, however, limited in extent. The pituitary giant does not exceed the dimensions of the man of high normal stature any more than the normal exceeds the small individual or the dwarf. But if the person or animal bearing cancer lives long enough, the bulk produced may be enormous. In animals, such tumors often exceed the total body weight of the host, and by transplanting to a fresh host additional quantities of tumor material can be obtained so that if sufficient animals were available it would be a very simple matter to produce a bulk of cancer tissue larger than this room, and that in a few weeks. Thus the ordinary conditions which limit growth do not apply to tumors, for the latter seem to be completely outside of influences which shape the complex structures known as the body. The embryonic tissues are also endowed with this same capacity for indefinite growth, and strains of chick embryo tissue are now twelve or thirteen years old, growing in plasma culture. But pituitary extract does not make a tumor grow faster, nor does it increase the growth rate of embryonic tissue in vitro. Its effect is upon complex organized systems only, and to these tumors and tissue cultures in vitro do not belong.

Now as a tumor is a part of the body in which it occurs and has the same protein constituents in its cells, it can obviously incite no reaction against itself. If it did, it would never start. The ordinary immunological reactions that are so valuable in detecting parasites, either simple, minute organisms like bacteria, or large complex parasites like the cestode worms, are not given by a growing cancer any more than by the embryo growing in the mother's womb. By the same token the neoplasm produces no effect on general health provided only that it does not in some mechanical way interfere with important bodily functions. That cachexia is due to some poison given off by the tumor is a myth. Sepsis following ulceration, pain, anxiety, loss of sleep and appetite, and interference with necessary life functions, are the reasons for cachexia, not a tumor poison. In animals grafted tumors may reach enormous size, and yet the host be in perfect health, provided the tumor does not prevent the taking of food. The growth of a cancer does not cause pain unless nerve trunks are pressed upon. Hence pain often appears only late in the disease. So little disturbance may be caused by a tumor that an internal growth may not infrequently determine the death of the patient without producing enough characteristic symptoms to admit of its diagnosis. Routine post-mortem examinations reveal the fact that from 20 to 40 per cent of deaths in those over fifty years of age are to be attributed to unrecognized cancer, and this in spite of every artifice of modern diagnosis. Therefore the patient must be educated to know something of the vague symptoms which accompany cancer, though no knowledge will prevent the deaths due to the unrecognized forms. But of the remaining 60 or 70 per cent of the cancer population, the symptoms are sufficiently definite to cause the individual, if he is intelligent, to consult a physician, and to cause the physician, if he is intelligent, to refer the patient to a surgeon who, again, if he is competent, may obtain a cure if the site and nature of the growth permits. But a large amount of education is necessary for all three groups, for a survey of the records of any hospital in one of the larger cities, where a certain amount of intelligence may be assumed in the population has shown that, excluding cancer of the skin, not more than 20 per cent of those applying for relief from cancer are anatomically operable and of this 20 per cent scarcely 10 out of 100 ultimately prove, when operated upon, to have any chance for cure, and if the operation is poorly done, the possibility falls much lower. So I think we can safely say that in the United States, with all the undoubted skill of its physicians, that scarcely one person in 20 has a chance for a cure. Individual types, such as cancer of the lip, in communities which have been trained to think straight, and in the hands of a surgeon like Dr. Bloodgood, have become a curable disease in a large percentage, for such patients are coming earlier. We see the same thing in the City of New York. My own surgical experience is only some thirty years, yet I can remember when our wards were filled with hopelessly inoperable cases of cancer of the breast. Today a fair proportion of the patients are coming in with tumors so minute that they are impossible to diagnose clinically and a microscopical examination of the tissue is often required to determine its nature. This is wholly the result of education. In fact, I sometimes think when I see the poor work done by some of our less competent physicians, that the public in the City of New York are better educated on the subject of cancer control than the average doctor. People therefore must be taught all the symptoms that are suggestive; they must be taught to consult a physician promptly, and after the age of forty-five, which is the time when cancer becomes a menace, to have yearly examinations, especially if there is a history of cancer in the family. Physicians must be trained to make diagnoses upon very insignificant and confusing symptoms or, if they cannot make such diagnoses, they must be taught to realize that the life of the patient depends upon their referring that patient to someone who can make a diagnosis, and unfortunately the one who can make a diagnosis often has to be stimulated to see that the patient undergoes the proper form of treatment with the greatest promptness. For it has been repeatedly shown that not only do patients delay for a long time before consulting a physician, but that the physicians not infrequently delay making the diagnosis and referring the patient for treatment. This situation is distressing and there is much to be done in the way of education. When the diagnosis has become probable, the decision as to the type of treatment is a delicate matter and depends very greatly upon the available skill in the vicinity. Fortunately, cancer is a transportable disease, and I look to the time when there will be established in this country institutions with skilled surgical staffs whose function it will be to care for all the cases of cancer within a radius of two or three hundred miles. There will be plenty of material for such a hospital and ample intellectual and financial reward for the surgeons who fit themselves for this type of work.

One of the great difficulties in the treatment of cancer at present is to decide upon the correct type of treatment. This is not wholly a matter of prompt surgery. Any interne can successfully remove an appendix. It takes but little time to teach a man to do a hernia, and do it admirably, but the distribution of cancer is so rapid and so extensive, and recurrence is so inevitable if the growth is not completely removed, that cancer surgery becomes a desperate matter and needs the highest training in pathology, anatomy and the skilful use of all the mechanical aspects of surgical technique. Every year there come into the wards of any large hospital unfortunate creatures who have been subjected to imperfect operations, and who, their fears being allayed by reassurances from the physicians who have done the work, do not realize that they are face to face with the specter of Too Late. Nothing can save them. These people say things about the medical profession which are painful to hear. In no other type of surgery is it so difficult to conceal incompetence as in that of cancer. Granted the most competent may be unable always to effect a cure, but when the case is within the curable limits, the results should be better than they often are.

Much harm has been done in the past few years by the wide publicity given to the remarkable results occasionally obtained by radium and x-ray. This has led people to believe that these results are invariably obtainable and permanent; that they are produced by a method which is painless (a statement which is far from true) and that surgery is no longer the method of choice. It is important, therefore, for our educational work on cancer that those who are doing surgery or applying x-ray, should codify as quickly as possible the essentials of their knowledge, and after reaching some statement to which all can agree, should see that this is so broadcasted that both the laity and the medical profession can have no doubt as to the relative effectiveness of these therapeutic agents. There are a few places, for example, in the United States, where an operable cancer of the cervix uteri can be treated just as well by radium as by surgery. But these places are inaccessible to many who suffer from this disease and to recommend radiation in the hands of the incompetent rather than surgery in places where good surgery is available results in only one thing, and that is the death of the patient. With all possible education, with the utmost attention of all those concerned, both patient and physician, there will be persons and many of them whose lives are in jeopardy before the evidences of disease are definite. These people must not be subjected to meddlesome surgery. They should not be tortured by overdosing with radium or x-ray. They should not be assured that they are going to be cured. Such treatment and assurance are bringing undeserved discredit upon all methods of treatment, especially radiation, which, while it is in most cases only palliative, still has a splendid field in such palliation and in a few types of cancers offers the only chance which the patient has of prolongation of life.

Thus education is needed for the public, in order that they may go to a physician; it is needed by the visiting nurse in order that she may note obscure symptoms and encourage the patient to go to a physician, and by the public health official that he may collaborate. The physician must be educated while he is a student and interne to diagnose cancer. He must have his knowledge refreshed from time to time concerning the newer methods of diagnosis. The surgeon must train himself in the most rigid intellectual honesty. He must not say "I hope I got all of that growth out." If he is not sure that he can remove all of a cancer, he should find someone who can. If complete removal is impossible, the patient either should not be subjected to an operation, or that operation should be planned as a preliminary to palliative radiation therapy and should be understood to be purely a palliative procedure.

It is a sad fact that the greater the publicity given to the subject of cancer, the larger the business of the quack, so that another phase of this cancer education is not only to teach the positive things about the disease, but the negative. We see almost weekly patients whose tumors have been "dissipated" by some member of the mechanical cults, with the result that the growth is distributed throughout the body and the patient's death rendered a matter of months. We see pitifully advanced cases who have hoped that Christian Science might stop the growth of a tumor. We see patients who have taken serums, vaccines, colored lights, and diets, under the assurance that if money is paid a cure will result, and the history of these patients is often that, at the inception of the treatment, the growth was small and easily removable, with a reasonable hope of cure, provided it had been removed at the time first noted. We must educate then against the quack. The quack without a medical license is not so difficult. He can be attacked through the machinery of the law in many states. Publicity is his worst enemy But the most dangerous quack is the medical practitioner who has lost his honor and is willing to make money by any means. I have tried in a number of cases to have patients sue such a man for malpractice, but it is rather touching to see how unwilling they are to do this and how they say, "Well, the doctor did the best he could, and I can't complain." Nevertheless, I think this is the only means to stop the work of this class of super-quacks.

It is of the utmost importance in this warfare against quacks of both varieties that facilities for testing alleged curative methods should be available, but unfortunately they are few. My own laboratory tests all quack remedies which we can obtain which seem of sufficient importance to warrant the expense. Of course I receive annually hundreds of specimens of salves, pastes, and plasters of various types which can be ignored, but the major humbugs I try to test on animals, for I believe that a remedy which will not cure one of the transplanted animal tumors will not cure a human tumor. With widening of the activities of the cancer quack in this regard, owing to modern advertising facilities, broadcasting, and other means of obtaining publicity, I think such facilities should be increased and carried through to the cautious testing on human beings with advanced cancer, provided that the alleged remedy does not cause pain or other damage, and the patient is willing to make the trial.

Another matter which is important from the educational point of view is to try to prevent the press from making announcements of perfectly ridiculous claims. Such papers often refuse straight advertising from acknowledged quacks, but freely publish matter equally bad. I have always found the newspapers glad to check up on any piece of news of the sort which comes in over the wires, and I have frequently been able to prevent the insertion of well worked up advertising material from a number of our best known quacks. The newspaper should realize that this advertising should go in the advertising columns if anywhere, and be paid for and not run with headlines on the front page. But the physicians of any community can always in a quiet way exert a restraining influence on the local editors which will prevent this type of advertising and save many people from losing both their money and their lives.

The very great slowness of production of new material on the subject of cancer by research workers is irritating to the public, and is occasionally given expression in the newspapers in the form of statements that despite the efforts of physicians nothing new has been learned about cancer. I have even had a well known banker whose income per year was five times the budget of my laboratory, criticize the work therein because after ten years of toil we had not discovered the cause of cancer. And yet the banker seemed to think the question exceedingly impertinent when I inquired whether, after all these years of large salary, he had made any real contribution to the subject of banking. Such an intolerant attitude is based on ignorance of the difficulties of the subject, and is regrettable because it makes the task of education still more difficult than it is. For it is a definite part of the educational problem to make people realize that the investigation and the ultimate discovery of the cause of cancer, or the cure for it, is not a matter of a few months and a few thousand dollars, but is a problem of the utmost difficulty and expense, and that there is no evidence at the present time which would warrant the hope that a cure for, or the ultimate cause of, cancer is likely to be discovered in the immediate future.

Another aspect which is part of cancer education is to encourage research, both statistical and experimental. Our statistics in this country are quite inaccurate, due largely to the fact that death certificates are too often based upon a cursory examination and not upon a careful post-mortem study of the case. Until such post-mortem diagnosis or the results of microscopic examination of operative material become generally available for cancer statistics the true rates cannot be determined, nor will it be possible to find out whether certain occupations or certain social habits play any part in the production of cancer.

For these reasons and many others which there is no time to consider here it is absolutely necessary to educate the public to be interested in and give support to the laborious work which may require generations before it succeeds in producing something which will influence favorably the wild growth of the cancer cell, and to teach it not to be impatient and critical if the work seems slow. But if the known facts concerning the cancer situation are serious, there is no reason for surrendering to mere inert pessimism and refusing to attempt anything until the cause of cancer is known. With sufficient funds, with intelligent courage and well directed enthusiasm from those who are interested in this problem, I believe that the public, the doctors and the nurses can be educated, the quacks driven from the field, and, with no more effective methods than we now possess, 30,000 persons can be saved in the United States every year from death by cancer.

By what means or through what agencies can this education be accomplished? As in many of the professional reforms the stimulus has come partly from the outside. Some thirteen years ago a society known as the American Society for the Control of Cancer was founded by a group of surgeons and philanthropic citizens to carry on just such an educational campaign throughout the country. They were not the first, for Winter, of Kiel, Germany, had years previously educated the people in and about that city concerning the importance of early diagnosis and early treatment with most encouraging results, but for a long time such efforts remained individual and sporadic. The American Society went on through the four years of the war on a small scale, but now has expanded considerably and is conducting educational endeavors throughout the whole United States and in Canada. These endeavors have been aimed at including everyone in the teaching staff, lay speakers, physicians, public health officers, State Boards of Health, dentists, nurses and medical students. Even the Census Bureau has issued an important bulletin on cancer at the suggestion of the Society. It publishes leaflets and pamphlets and distributes them in stores, schools and factories, at club meetings, public lectures, and at the annual conferences of the various medical societies. Primarily the attempt has been made to tie all of the work to the medical profession in order to avoid antagonism on the part of the doctor. In all of the publicity which is carried on the patient is told to go to his physician. The Society never attempts to make diagnoses nor to instruct the patient to diagnose his own disease. Instead, the individual is told, if he or she has certain symptoms, and those symptoms are suggestive of cancer, to go to the best physician available and obtain advice. Such information by the Society was not at first very cordially received by all of the medical profession. There was talk of inciting cancerphobia, of driving people to quacks, of commercializing medicine, but gradually there has been a very marked change and last year a large number of surgeons testified in writing that in the past ten years there had been evident a great change in the stage of the disease at which patients came for consultation. Many more of such patients were operable than at any previous time.

The most cordial coöperation has been given by many state and city health boards, though of course such boards are unable to offer financial assistance because their funds are largely appropriated for the control of contagious diseases. Cancer has never been made notifiable and the idea that boards of health should give instructions on the symptoms of cancer is too new for general acceptance. There are always critics who say that this is the business of the government, but the government is at present interested only in the diseases of chickens, pigs and cows, and it is clear that this Society must at present continue in the course in which it started, enlisting as far as possible the interest of all those who can be teachers. In this connection the public health physician and nurses, the social service worker, and the dentist are often in a position to do valuable work because the public always have a certain suspicion at the back of their minds that doctors are drumming up business for themselves. The recent extensive development of yearly health examinations by some of the leading insurance companies, and the invasion of the medical field by corporations, such as the Life Extension Institute, has contributed a great deal to the Society's work by teaching people the value of yearly examinations.

I see no end to this work, for as it has been said, there is no immediate prospect of a medicinal cure. Each generation must be educated and re-educated, for as Winter has recently found, the psychological breakdown following the war has, in his experience at least, resulted in an astonishing indifference and consequent great increase in the large number of inoperable patients finally consulting him.

A more difficult problem is the education of the physician, especially the older man, who resents somewhat the implication that he needs new knowledge. Part of this education must be accomplished directly by pamphlets, books, and articles in the medical periodicals. For example, every member of the medical profession in Massachusetts received a well written text on the diagnosis and treatment of cancer. The cost was met partly by the Society and partly by private donations. But this education should also be indirect by having the physician's patients better informed than he is as to the symptoms and treatment of cancer, and thus forcing him to learn. One intelligent woman told me that she had had to consult four surgeons before she could get any attention paid to a small lump in her breast, and yet when that lump was excised, it proved to be a carcinoma.

The public health officer and the nurse should have especial instruction in the diagnosis of cancer in the early stages, for they see in the course of their duties a large number of people who do not consider themselves ill enough to consult a physician, and these constitute just the group whose treatment offers the best hope of a cure.

I think I have said enough to show that cancer education is a large problem; that it is one in which only the surface has been scratched, for we cannot feel any great satisfaction in our teaching so long as the recorded death rate from cancer increases. I think also it must be clear to everyone that no educational agency can be omitted from the faculty of this great university for instruction in cancer, an institution which should have representatives in every village in the country. The greatest difficulty lies in the nature of the disease. It cannot be handled by public health methods which strike at the source, as in typhoid or tuberculosis or diphtheria, but implies the direct education of people at an age when they are apt to resist instruction, for it is only after forty-five that cancer becomes an important cause of death. If a simple and sure cure could be offered, the problem would be easy, as the amount of patent medicine consumed in this country proves, but the recommendation of surgery, x-ray or radium treatment does not stir enthusiasm in any human soul. Nor can we promise from any of these methods an extraordinary proportion of successful results.

But are we to sit with our hands folded until such time, years hence, when we may hope some scientist will discover an easy cure? That is scarcely worthy of the spirit which drove the pioneer to this country and is still driving the new world. I should regret to see the people of this country permit this movement to fail of achievement, for surely the saving of thousands of lives yearly is well worthy of our highest endeavor.

SOME PROBLEMS IN RURAL HYGIENE

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Rural and urban public health problems are so closely related one to the other that they cannot be considered as separate problems. Due, however, to environmental and social conditions these problems require different methods for their solution. Rural problems deal largely with the individual, while in cities it is chiefly a mass problem.

Health regulations in cities are more or less arbitrarily enforced by a well organized health department, leaving little individual responsibility to its citizens. Legal enforcement of public health ordinances are not difficult in cities. In the country, however, their enforcement is largely a psychological problem. To attempt legal enforcement without first having tried diplomatic methods excites antagonism on the part of the rural dweller. To serve a legal notice on a peace loving farmer is regarded by him as an attack upon his personal character and his community standing which he will resent with the utmost vigor.

To be successful in dealing with rural people one must study their problems. The rural dweller is reluctant to accept opinions from experts unless that expert can discuss his own problems intelligently. If possible do not allow him to express an adverse opinion on an important subject prematurely. Once he has expressed his opinion he is reluctant to change it even though he is convinced of his error.

Traditions and superstitions have in the past been a great factor in retarding medical and sanitary progress in rural communities. With improved educational facilities and greater opportunities for social contact through rural organizations these difficulties are rapidly disappearing.

The medical profession is largely responsible for the empiricism which pervades the country. The substitution of the scientific practice of medicine for the former empirical methods is of comparatively recent date. Many of the crude medical practices in the country homes today are based upon the advice of some honored physician of the past. Due to empirical methods the country people to a large extent believe that disease is never cured except by the administration of drugs and that there is a medicine for the cure of every disease if it can be found. As a result of our neglect they have little knowledge of the principles of immunity, the fact that many diseases are self-limited and that the chief duty of a physician is to see that nature's plans are not interrupted. So long as the practitioners of medicine give placeboes instead of taking the time to explain nature's plan these conditions will exist. The belief that the physician's services are of no value unless he gives medicine is one of the greatest factors in the promotion of the sale of quack nostrums. The charlatan and the quack are living today largely on the irrational practices of the medical profession. We must treat our patient as an intelligent human being whether he lives in the city or country. To ignore or ridicule functional disorders and trivial ailments will tend to drive the patient to the charlatan. To use medicines for all the ills of mankind will encourage the manufacture of quack medicines. To allow the people to believe that pathogenic germs are continually floating in the air or that they develop spontaneously from decaying vegetation instead of explaining to them some of the simple truths of pathology and the direct and indirect contact spread of communicable disease will greatly retard our work. Our opportunities for education of the public on health matters throughout the rural sections have been greatly increased during the last few years.

Through the large Farm Bureau and grange organizations and the multiplying of public health centers throughout the country we are given great opportunities for spreading such knowledge by means of lectures, moving pictures and other demonstrations. I find these people eager for knowledge on these subjects and my most popular lecture to granges and other rural organizations has been on the general application of the principles of immunity.

However, with these added facilities for social and educational conferences other problems have arisen.

There is a growing scarcity of physicians in rural communities. This is but a natural consequence of changed living conditions.

Various methods have been proposed for checking this tendency. This problem cannot be solved by attempting to secure more physicians for these communities. We must attempt to solve it in a more practical way.

With the advent of the telephone, the automobile and good roads the rural dwellers no longer are dependent upon local physicians during the eight or nine months of the year when the roads are open to travel but do expect the same care that they formerly received during the winter months. As a result of these changed conditions there remains but one physician in places where there were formerly two or three to care for large rural sections. This frequently results in serious lack of medical service in these communities during the winter season. We are attempting to solve this problem by establishing cottage hospitals or what the English term "nursing homes" which shall be located near the physician's house, shall be equipped with a suitable lying-in room, comfortable but not elaborate furnishings and with efficient practical nursing service at a moderate cost to the patient. Maternity, emergency and other cases requiring close observation and daily visits from the physician can be brought to this hospital where the physician can give them good care night and day, leaving only the chronic and less important cases to be visited by the physician at their homes. This hospital can be made available for emergency cases during the entire year. One such emergency hospital has been serving a large rural section admirably for more than a year. The hospital can be made the center of a public health nursing district under the care of a generalized public health nurse who will be available for prenatal, child welfare and school nursing duties of which these communities are sadly in need. By these means the public can be stimulated to greater interest in public health work. Breast feeding for babies will take the place of proprietary foods. Defects among school and pre-school children will be corrected, immunization against smallpox and diphtheria can be secured, and a better physical and moral community developed.

MILK AND WATER SUPPLIES

Much attention during the past two decades has been given to the urban milk and water supplies. This urban activity has had a marked effect upon rural communities. The increasing stringency in milk production regulations for large cities has been a great factor in improving rural sanitation. These requirements have given rise to better epidemiological investigation of communicable diseases. A few decades ago typhoid fever was a common disease in rural communities with the result that many healthy carriers of the bacillus typhosus exist among dairy workers which are responsible for many outbreaks of this disease among the milk consumers of our larger communities. By recent intensive work of Welch and Havens in Alabama fifty-five typhoid bacillus carriers were found among 1076 healthy persons employed in the dairy industry. The Minnesota Board of Health since 1913 has discovered 131 typhoid carriers responsible for 644 cases of typhoid fever including 46 fatalities. In New York State since 1914 there have been 59 milk-borne typhoid fever outbreaks responsible for 851 cases resulting in 52 deaths. Practically all of these outbreaks were traced to typhoid bacillus carriers on dairy farms. The locating of these carriers is one of the problems of the rural health worker. Careful epidemiological records will greatly assist in locating them. The examination of the excreta from convalescent typhoid cases and keeping these cases under observation until several negative results are obtained will aid us in the solution of this problem. The routine examination of the contents of all gall bladders removed or drained surgically in hospitals which receive patients from rural sections has assisted us in locating some of these carriers. General milk pasteurization would solve this problem but it is difficult to secure such pasteurization in all communities. Better sanitary supervision of water supplies has been a great factor in eliminating typhoid fever.

THE HOUSE FLY PROBLEM

The fly nuisance which is a source of so much trouble in the country homes can be entirely eliminated by proper educational methods. Substitute the elimination of fly breeding places for the slogan "Swat the fly." To swat a score in the house and breed a million in the yard has little effect upon this problem. The establishment of an annual public health day where the pupils from all of the schools of a rural township with their parents may assemble in a large community building where lectures and instructions may be given by means of lantern slides and moving pictures under the direction of public health officials, taking up all phases of the fly problem has accomplished this object. Make this a yearly social and educational function. The rapid development of road lunch stands, municipal camping grounds and juvenile summer camps call for stringent State laws for their regulation, and the enforcement of these regulations by the local authorities, particularly in regard to water and milk supplies and the personal hygiene of food handlers.

PUBLIC HEALTH NURSING SERVICE

Public health nursing service in rural communities is sadly neglected. School medical examinations in the past have been superficially done and little follow-up work for the correction of the defects has been attempted. The pre-school child needs better supervision and care. We find upon study of children of this age that the teeth begin to go bad at about the age of two years and by the time the child reaches school age have reached a serious condition. In many cases these defects date back to the early months of childhood in homes where the mother has not been properly instructed as to the importance of infant feeding.

In a careful examination of 4078 rural pre-school children we found that 8.8 per cent of the children showed carious teeth at the age of two years, 21.9 per cent at three years, 40.1 per cent at four years and 50.7 per cent at five years. Just how far these carious teeth are responsible for other ills it is difficult to say. It was the writer's observation, however, that in practically all children of this age who had good teeth we did not find tonsillar infection. In a study of the conditions among 4000 supposedly healthy babies we found that 829 babies had been nursed less than six months and 978 had been fed exclusively on proprietary foods. These conditions have been brought about partly by the clever advertisements in newspapers and other printed matter on the value of proprietary foods, and by lack of instruction on the part of physicians and nurses relative to the importance of breast feeding for babies. Few, if any mothers in the rural section will be unable to nurse their babies if they can receive proper instruction from qualified public health nurses during the first few weeks of a baby's life. The value of this work in reducing our infant mortality cannot be overestimated. By an intensive campaign on breast feeding in one of the smaller cities of New York State the infant mortality rate was in one year reduced from 62 to 24 per thousand births.

RURAL SCHOOL MEDICAL INSPECTION

Medical school examination has not progressed in the rural schools to the extent that it has in our city schools. The chief reason for this is the lack of appreciation of the importance of this subject and the consequent lack of funds for carrying on this work. The opinion has prevailed that we cannot make thorough physical examinations in the small rural schools. We have recently disproved this belief and are now in certain sections carrying on rural school examinations and the follow-up work of correcting defects as thoroughly as it is done in cities.

Under a plan recently instituted in Onondaga County, New York, a public health nurse goes to the small rural school, weighs and measures the children, tests their sight and hearing, and gets as much of the child's family history as possible on the day previous to the visit of the medical school examiner. The next day she assists the examining physician by baring the children above the waist, the child and examiner being screened from the rest of the school, she tabulates the results of his examination, and after a sufficient number of schools have been examined, she, under the direction of the examining physician, visits the homes of the children in whom defects have been found and arranges for the correction of the defects through the family physician of those who can afford such service and through clinics where the parents are unable to pay for it. Our nurses have been able to secure parents' consent for giving toxin-antitoxin to nearly 100 per cent of the school and preschool children during such follow-up work, all of whom have been given toxin-antitoxin.

BETTER COÖPERATIVE RELATIONS BETWEEN FAMILY AND PHYSICIAN

Due to the higher cost of medical service and the tendency toward specialism in medicine the relation of the physician to the family especially in rural communities has been greatly changed. The physician of the family as a wise counselor and friend has gradually disappeared. There is in consequence a growing tendency for the people to purchase their medical service at bargain counters and to be led into the hands of the charlatan through improper advice. This can largely be overcome by establishing annual periodic health examinations for all the apparently healthy members of the family, these annual examinations to be performed by the family physician. Such examinations will bring the family physician into closer touch with his patients, will serve to detect defects and disease in their early development, and also lessen the morbidity and mortality of many diseases, especially those so common among people of middle and advanced life which are shown by our statistics to be rapidly increasing in their prevalence.

The question naturally arises, "To whom are we to entrust this better supervision of rural public health work?"

I believe that this work can best be accomplished by establishing County Health organizations under the direction of full time County Health Officers, who shall be provided with a sufficient budget to carry on his work. Much effort has been made during the last few years toward the establishing of such units. On January 1, 1925, there were in the United States 280 such full time County Health Officers. The state with the highest percentage is Ohio with 50 per cent. New York State has one such unit. In order to secure such County organizations, most if not all of them have received financial assistance from unofficial agencies. From the progress which has been made it is very evident that a more intensive educational campaign should be carried out in rural counties for the purpose of supplementing the work which is now being done. Dr. Lumdsen states that at the rate of progress since 1920 it will take about eighty-five years for whole time rural health service to extend to all counties of the United States in which such service is needed. In the meantime we must exert our efforts largely in the education of the partially trained sanitarians now employed.

In January, 1916, with this object in mind the writer submitted a plan to the New York State Public Health Council for a short term course to meet these conditions. The plan which was approved by the Council consisted of combining reading and resident work, extending over a period of twelve weeks, two days of each successive week being spent in class work, which includes four or five hours each day devoted to lectures, practical demonstrations and conferences. The program is so arranged as to link together correlated subjects. Sufficient opportunity is given the men for conferences among themselves for the purpose of checking up the subject matter in their minds. The lectures and demonstrations are given by men of wide practical experience in the subject assigned to them. They are selected from universities, municipalities and the State Department of Health. The classes are conducted at a season of the year most convenient for the men and every effort is made to conserve their time. About 100 hours of intensive work are consumed in this Course.

Our first class started in March, 1916, at Syracuse. Twenty such classes have now been held in the cities of central and western New York. About 300 health officers have availed themselves of this instruction. We believe that these Courses have done much toward stimulating the profession and public to higher aims and will do much toward obtaining full time County Health Officers. They have changed the attitude of public health officials in regard to the duties of a health officer.

The conditions under which most health officers have been expected to produce results have been most discouraging. They are underpaid and are given no financial resources for health activities; they are appreciated by the community and their boards of health for what they did not do rather than for efficient service; they are isolated from those of similar interests, with little or no opportunity given them to keep in touch with the newer methods and facilities of preventive medicine. Insufficient knowledge of laboratory methods has given rise to misunderstandings and doubts as to the value of the laboratory.

Efficient service can come only from self-confidence inspired by a knowledge of one's subject. It is only by efficiency that we can gain the confidence of the public and the respect of the physicians for our official positions. No matter how conscientious a public health worker may be, his enthusiasm soon wanes if he is conscious that his work is not appreciated.

In the past the majority of health officers have been selected for their political activities rather than for their fitness for the position, and the office is still regarded by some local boards as a political plum which should be passed around. The President of a rural Board of Health expressed to me the opinion that a health officer was not needed unless an epidemic was present. My reply was "Why do you support a fire department in your village when there is no fire?" To place his tenure of office beyond the dickerings of politicians the health officer must have a strong personality, must realize the great significance of preventive medicine and must not limit his services to the amount he thinks he is paid for but should serve his community with an unselfish devotion which will command the admiration of all.

THE IDEAL HEALTH OFFICER

The county health officer should be regarded by his community as a specialist in public health and hygiene. In order to meet the dignity of his position, his knowledge of public health subjects should be broad and comprehensive. His selection to office should be made solely in regard to his fitness. His duties should not be the perfunctory ones of a sanitary policeman, who is often regarded by the public as a worse menace than the disease which he quarantines. He should be entrusted with the giving of instructions as to the methods to be adopted in preventing the spread of disease—a function which the family physician too frequently assumes. Misunderstandings frequently arise from such an assumption. The attending physician should seek the health officer's advice in matters pertaining to health regulations in the same spirit in which he would seek the advice of the consulting surgeon or internist.

Through a better knowledge of public health, the work of the health officer should impress itself on the municipality in a manner sufficient to command the coöperation and assistance of all civic societies and organizations. His visits to the afflicted home should be looked on as that of a wise counselor and friend, and not as that of a heartless official to be dreaded. This will secure more prompt reporting of disease by the family. To secure such recognition he must possess certain qualifications of character and education which will command the respect of the entire community.

The health officer should be prepared to answer promptly and intelligently all questions relating to the fundamental principles underlying public health work, when such advice is asked by the local physicians. His knowledge of epidemiology should be sufficient to enable him to meet effectually all outbreaks of disease, and so far as possible, to trace them to their source.

The question naturally arises, "How can the Health Officer secure such qualifications without too great a sacrifice of time and money?"

When we consider the meagerness of his salary in proportion to his income from private practice, we are but little surprised at the query so commonly expressed, "How can I afford to do it?" In arranging our programs we have endeavored to furnish the health officer with a Course which affords him these opportunities with the least possible loss of time from his regular practice. It is of such a character that its teachings are of the highest value to him as a practitioner in medical subjects which are closely allied to public health work. Our aim is to open up to him the broader fields which he can cultivate by future reading. It would require years of training to qualify a physician as a specialist in bacteriology, but he can acquire in a comparatively short time the fundamental principles of laboratory work and laboratory methods which will enable him to appreciate their limitations and the wonderful assistance to be obtained from them when they are properly understood, and to use the laboratory to assist but not to displace clinical methods of diagnosis.

The health officer should, in a general way, know the principles which govern the growth and propagation of bacteria, something of their morphology, selective staining, and the difficulties encountered by the bacteriologist when specimens are improperly collected, tabulated and dispatched to his laboratory. He should have some knowledge of the methods used in isolating pure cultures and for what purposes they are isolated. He should know what is meant by "darkfield illumination" in the diagnosis of certain diseases; the principles underlying agglutination tests and complement fixation; and the methods of ascertaining the various types of pneumonia for the purpose of serum treatment. He should understand some of the underlying principles of immunity, both active and passive, and the great value of immune serums when administered properly. He should understand in a general way the phenomenon of anaphylaxis and the dangers of administering large amounts of foreign proteins without suitable precautions, and the effects of horse serum products on asthmatic patients. He should have some knowledge of vaccine therapy and its limitations. He should understand the difference between vaccines and immune serums. He should have a general knowledge of the production of diphtheria antitoxin, its standardization, dosage and administration under varying conditions; how Vincent's angina can be distinguished from diphtheria; what we mean by the Shick test and its application; the toxin-antitoxin methods of immunization against diphtheria; the Dick test and its application; how to secure blood for the Wasserman test and other similar reactions; methods of making spinal puncture and its importance as a diagnostic and therapeutic measure in certain meningeal affections. To my mind, the knowledge of these various phenomena cannot be obtained without practical demonstrations and conferences with competent teachers; reading alone is totally inadequate. If this work is to be taught effectually, the class must be limited in numbers, and we must have only teachers who are practical and who have the enthusiasm and personality which will bring out the difficult points through personal questioning, explanation and painstaking demonstrations. The same methods should be used in demonstrating other phases of the work. Practical demonstration is given in the early diagnosis of tuberculosis by the best specialists obtainable. The class is shown that sanatorium control of this disease should be both educational and for the arrest of the progress of the disease. The health officer should be familiar with the treatment of venereal diseases, and have practical demonstrations in the administration of their remedies and, so far as possible, be taught the technic of intravenous therapy by actual demonstration. The same practical methods should be used in demonstrating school examinations, school inspections and the problems underlying its various branches. He is shown open-air schools in operation. He is taught the value of substituting industrial teaching for the atypical and backward pupils. He is taught industrial hygiene, and personal hygiene in the handling of foods. He visits certified dairies, milk pasteurization plants and ice cream factories, and is shown the methods used in scoring dairies by men of experience. He visits hospitals for communicable diseases and observes these diseases in their various manifestations throughout their course. He is taught the rôle of the disease carriers in the spread of diseases, and how best to protect the public from them with the least amount of hardship to the afflicted family. He is taught the various methods for the purification of water for municipal purposes, including chlorination, the mechanical and the slow sand filtration and the advantages of each. He visits sewage disposal plants in operation and the various other municipal health activities. He is given practical demonstrations in prenatal care and infant welfare work. He is taught the value of vital statistics and the general laws governing such activities, and he is well drilled in the requirements of the sanitary code.

The sacrifice of time in the weekly attendance has, of course, been great, but none have complained. The effect on the morale and efficiency of the health officers can hardly be overestimated. A higher spirit of coöperation was manifested; keener interest and enthusiasm in the development of new activities in their municipalities has been very evident; greater confidence in their own ability to meet their health problems has been shown; also a higher appreciation of the efforts of the state health department in the control of disease. Boards of health have shown greater confidence in the health officers who have taken the courses, as has been manifested by increased remuneration and better coöperation in a large percentage of the municipalities. Many of the local boards have borne the expenses of the course; there has been less tendency to change the tenure of office of the qualified men. We fully realize that the ideal for which we are working can be accomplished only by the securing of well-paid, full-time county health officers, but until we can create public sentiment and an appreciation by physicians of the great importance of preventive medicine, we must use the material at hand, not only to meet our present health situation, but in order to stimulate the public to a better appreciation of public health work. We should in every way possible try to secure the coöperation of physicians in the development of this work. Indifference or antagonism on the part of physicians is a great factor in defeating our efforts to obtain such country health units.

I was obliged to accept defeat in two counties largely on account of my not having fully appreciated this fact. Indifference on the part of physicians will often defeat our plans. We all have an influence whether consciously or unconsciously expressed. Let us capitalize this influence to our fullest extent. The health officer's motto should be, "Efficiency first, safety always, courtesy to all." The following legend placed on the office entrance door might not be inappropriate for some municipalities, "Come in without knocking, and please go out the same way."

INDUSTRIAL HOUSING AND PUBLIC HEALTH IN METROPOLITAN REGIONS

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I. INDUSTRIAL CONCENTRATION

This is the age of large cities. The great urban aggregations of modern times have no counterpart in history. Many of the problems they have created are new problems, or they are old problems under a new guise or reshaped by new conditions. Mechanical processes of manufacture have brought about the industrial concentration that has grown up around ports or at the base of supply of raw materials of industry—while mechanical propulsion of the vehicles of transport has made it possible for this concentration to expand over vast areas. And so New York, Philadelphia, and Baltimore—for example—are no longer compact cities, but great metropolitan regions. There are twelve metropolitan regions having 500,000 population or over in the United States, as against seven in Germany, five in Great Britain, and three in France. China has the same number as the United States.

Parallel with the extensity of urban growth in these regions, we have an intensity of concentration of business activity, amounting in many cases to congestion, in their central areas. Thus on one hand we have the problems created by an unprecedented expansion of suburban growth; and on another hand those created by an unprecedented aggregation of centralized growth.

II. PROBLEM OF SEPARATION OF WORKERS FROM PLACE OF EMPLOYMENT

Incidental to these two problems we have that of the growing separation of the home of the worker from the place where he works. The scale or distance of this separation is made possible by increasing rapidity of transit facilities. The questions of geographical extent of area, of congestion of central districts and of means of transit by trolley, subway, or short distance railroad in city regions, interlap in their relations, and separately, as well as in combination, are related to the question of housing. We may summarize some of the features of these inter-relations thus:

1. The business districts in the center require their complement of dwellings within close proximity to provide for those who work long or inconvenient hours. The character of the dwellings in these central areas is influenced by high land values due to competition with business use and other causes. This influence reveals itself in intense building development and in lack of space about buildings, for purposes of giving adequate light and air to the dwellings. If the prevailing type of dwelling is an apartment in a tenement building as in New York, the lack of light and air is more pronounced than in cities like Baltimore, with its lower buildings and greater number of self-contained homes. Transit has its smallest bearing on this class of housing.

2. When industries move from the central to suburban areas the workers for a variety of reasons very frequently remain in the center and travel daily to the suburbs. The reasons for doing so have to be strong enough to justify the higher costs of residence in the center as compared to the suburb, plus the cost of transit to the commuting worker. Transit is an important element in this class of housing, but usually no problem of congestion of transit lines arises because this class of traveller is not so numerous as that which travels the reverse way. In some parts of New York and London, the number who live in crowded centers and travel outwards to the fringes has increased during the shortage of houses following the war.

3. The increment of land values in central districts, the replacement of residential by business use, and the improvement of facilities for transit have greatly multiplied the commuting class who live in suburban areas and travel daily to work in the centers. This class creates the dormitory development we see around all large cities,—the new subdivisions with their speculative features and too frequent lack of proper sanitation and durability in construction. Transit is essential to this class,—and in the larger cities the form of transit has to be rapid, and, to a considerable extent, underground.

4. In some cases industries and workers move out together to suburban or semi-rural areas, or industries are established in these areas and attract workers to follow them. This reduces the number of commuting employes. Whatever defects may exist in development of suburban land will affect this class, but transit to the center is only of secondary consideration and may be of little account if the suburban communities are self-contained in their social life, i.e., provide ample facilities for education, recreation, amusement, and domestic trading.

In so far as we can promote the lessening of congestion and remodelling of central districts so as to permit of healthy housing near to occupational areas that must continue in the center, we will help workers of the first of these four classes to avoid waste of money and time in travelling, and relieve transit congestion. Unfortunately it is in central districts that the old congested slum areas exist and conditions are so difficult to ameliorate. The New York Commission on Congestion of Population gave figures to show that in 1910 about one-thirteenth of the city's population, namely, 370,000, were living at a density of 600 to the acre, while Lawrence Veiller says of New York that in no other city are there the same appalling conditions with regard to light and air in the homes of the poor. Congestion and hygiene conditions have become worse rather than better since 1910. If cities were built in the right way with sufficient space for health and convenience, we should have no difficulty in deciding that the best place for housing those who work in the central districts would be near to their work. In any event and under conditions as they are, part of any housing policy for improving housing conditions should include the replanning and reconstructing of slum areas, and the provision of as much healthy accommodation as is practicable in these districts.

The second and third classes are commuters. In many cities commuting has reached a point that is highly wasteful of time and money. No solution of the problem of congestion can be obtained as long as we continue to magnify distances between the homes and places of work. In course of time and under present conditions the elevator makes the subway necessary, and in turn the subway creates the economic necessity for higher elevators. Rapid transit may temporarily alleviate congestion, but when one of its objects is to provide facilities of communication for crowded districts with high buildings, its result is to assist and stabilize congestion.

We cannot therefore regard the present tendencies of city growth towards the development of crowded occupational areas in the centers, with inadequate limits on the heights and densities of buildings under the most advanced zoning laws, and with suburban dormitories segregated at long distances from places of employment, —however spacious and healthy the suburban areas may be, and however well provisioned with a system of rapid transit lines,—as a sound method of community development. Large cities are beginning to suffer under the economic strain, and the citizens under the physical and nervous strain, of conditions that appear to be inherent in modern systems of community development. But the extent to which these systems have become established, the existence of vested interests in real estate and public utilities, the habitual acceptance of drift as something that is unavoidable, have so entrenched the dual movements of aggregation and segregation in their present haphazard forms, that for the time being it seems to be the inevitable direction of urban growth.

It is not denied of course that there are great advantages in isolating residential from industrial and business areas, and indeed one of the merits of what is called the zoning plan is that it provides for reasonable and proper separation of different uses. There are advantages in having the worker remove daily from his factory or office to an entirely different environment. So long as the place where he lives supplies all the social needs of the citizen, other than occupational needs, the cost of transit may be worth while. But too often the commuter has to travel to and from the city for his cultural and recreational opportunities as well as to do his work. In any event, and allowing for all defects in this form of town development, it has taken a firm place in our system of community growth. No program of housing improvement can be complete without provision for better planning and regulation of the suburban dormitory.

Where an industry moves out to country districts outside the city, where homes and social amenities are provided for the workers in the same neighborhood as the industrial plant, the opportunity is made available for creating a properly balanced form of town development. This is the most hopeful form of decentralization as a means of obtaining healthy conditions, and is the only form that is effective in relieving congestion.

III. THE IDEAL CITY

The ideal city would be one which, while giving to its citizens that measure of natural beauty and spaciousness of the older towns of New England and the southern states, yet retained the cultural facilities and the advantages of concentration for business purposes of the large city.

In such a city the relations between buildings and open space would be adjusted so as to permit room for adequate recreation space for all inhabitants, for ample light and sunshine for all buildings and for conservation of a reasonable degree of natural beauty within and about the city. It would have a well-balanced distribution of industries, of residences, and of population, permitting of agreeable housing and working conditions, no unnecessary travelling, no underground systems of transit, and more productive use of vacant land.

There still remain in New England some of the towns that are more truly country than city in the modern sense. Some of them have conserved their beauty, and in so far as they have done so they reveal to us the conception of what the ideal city should be. Other New England towns are like Salem, of which Hawthorne wrote in his introduction to the *Scarlet Letter*. He described its flat site as being covered chiefly with wooden houses, few or none of which pretended to architectural beauty—its irregularity neither picturesque nor quaint, but only tame. These and other features, he said, it would be quite as reasonable to form a sentimental attachment to as a disarranged checker-board. He makes the remark that although "invariably happier elsewhere" he had a strong affection for his native town.

This ideal city or town, that will contribute in full measure to the well-being and happiness of man, and have the qualities of the town and country combined, probably is out of reach, but it should never be out of mind. There is no lack of space in this country to achieve it,—only the wrong use of space and the effects of want of planning in the past, which impose upon us practical difficulties that make achievement impossible. But the ideal conditions that are out of our reach in the areas already built upon, should be our guiding influence in developing policies and in promoting plans for all new urban growth.

IV. INDUSTRIAL HOUSING AND LAND DEVELOPMENT

We cannot make a right approach to the problem of industrial housing without regard to the conditions I have named and the ideal I have pictured. Any analysis of the modern industrial city leads to the conclusion that the problem of industrial housing is intimately related to all the other problems of city development, and that the defects of housing conditions are not only structural defects of buildings, but defects due to careless and improper systems of land development, unbalanced distribution of population and industries, and lack of understanding of the importance of maintaining an adequate scale of open surroundings in relation to the height and density of buildings. It will be noted that these are things for which public authorities and not individuals are responsible.

The house consists not only of the structure, but also of the following things which are necessary for healthy habitation, namely:

a. The land which forms the site of the house.

b. The public health services, consisting of drainage facilities, water supply, paved yards, and sufficiently open surroundings to permit of hygienic conditions and space for recreation.

c. The services necessary for convenience, including paved roads and paths and access to means of transit (where necessary).

When we consider the house in this comprehensive aspect, we can understand the many ramifications of the housing problem in relation to the general plan of the city or the region. Whether we look at it from the point of view of the methods of growth of the city as a whole or from the point of view of the individual home, we find that the improvement of industrial housing in metropolitan regions depends on comprehensive treatment of all the constituent parts of the physical growth of the city.

The great city of today is an industrial rather than a political unit, and I suggest that there can be no adequate solution of the housing problem in the industrial region unless based on a study of physical, economic and social conditions, and trends of development.

V. RELATION OF HOUSING TO REGIONAL AND CITY PLANNING

The relation between city or regional planning and industrial housing—which means the housing of perhaps two-thirds of the population—is perhaps illustrated in the most impressive way by the fact that in America and England the main objects of what may be called statutory city planning are to promote health, safety, and general welfare. Whatever we may do in making a city plan for purposes of convenience in connection with traffic and transit or for esthetic reasons, we cannot obtain power to enforce any physical improvement without payment for property which is required or suffers from damage. If, however, the purpose of our plan is to prevent some condition that will injure the health or endanger the safety of the citizen, we can carry it into effect under the police power without compensation to the owner of property, even if the result is to interfere with his liberty or lessen his profit. In respect of general welfare, courts in the United States have gone so far as to approve of plans that had the effect of stabilizing what may be described as agreeable, as opposed to strictly health conditions. Generally speaking, however, the courts insist on limiting the provisions of city planning and zoning schemes, so far as they can be enforced without payment of compensation for injury to property, to those things that promote health and safety. There has been a great advance in the attitude of the courts towards the interpretation of the police power—I mean an advance towards the view that open space surrounding buildings and limits of heights of buildings are necessary for health in addition to proper sanitary conditions.

In the English law we have even a stronger indication of the connection between industrial housing and public health under the law of city planning. What is known as the Town Planning Act of England had its origin in the movement to improve the housing of the working classes in that country. Indeed, the Town Planning Act was a definite part of the Housing Act of Great Britain of 1909. Its general object is set forth as the promotion of proper sanitary conditions and amenity and convenience in connection with the development of land. As construed in practice, the application of this object is mainly to housing areas. Among the provisions of the Act is the following (Sub-section 2 of Clause 59):

> Property shall not be deemed to be injuriously affected by reason of the making of any provisions inserted in a Town Planning scheme, which, with a view to securing the amenity of the area included in the scheme or any part thereof, prescribe the space about buildings, or limit the number of buildings to be erected, or prescribe the height or character of buildings, and which the Local Government Board, having regard to the nature and situation of the land affected by the provisions, consider reasonable for the purpose.

The effect of this provision is that the amenity or agreeableness of an area devoted to housing becomes a requirement under the law; and that the owner cannot claim compensation unless he is unreasonably damaged by this requirement. Then the scheme may limit the number of buildings to be erected on an acre and prescribe the space about them even if an owner suffers financial loss as a result. The prescription has to be reasonable, but it is carried to such a point in England today that in many parts, including districts within the County of London, not more than 12 houses may be erected on an acre of land under the law. Further, the restriction on height and character or use of buildings does the same thing as is accomplished under the zoning law in this country, namely, restricting building heights in relation to width of streets and prescribing the use of areas for different purposes such as industry or residence.

We thus see that in America and Great Britain the most effective provisions that can be included in city and regional planning schemes are those that relate to promoting public health in connection with housing, and that the promotion of safety comes next in importance.

With the aid of regional and zoning plans, efforts should be made on more constructive lines than hitherto to apply existing legal powers so as to secure the improvement of housing conditions in industrial communities. We want higher standards in regard to space about buildings in all areas, but especially in central areas.

In suburban and rural areas a particular need is that public authority shall require public health services to be provided as an essential part of a dwelling. When this is done it will no longer be practical to make wholesale subdivisions and sales of wholly unimproved land in suburban areas, for the building of homes. Before such sales take place the vendor should be required to provide proper means of access by paved streets, necessary sewers, and water supply. Injurious speculation in land is made possible chiefly because the speculator does not require to invest his capital in making the land fit for building on, but passes on the responsibility to do so to the purchaser.

A chief cause of defective housing in suburban areas is the wasteful and inefficient methods of platting new subdivisions.

One of the features of a regional plan would be to bring about a better system of controlling platting, under which the main purpose of platting would be to provide properly equipped sites for homes, and not merely opportunities for gambling in real estate. In undeveloped areas platting of land and restriction of heights, densities, and uses (zoning) should go together. That is the only way to make zoning effective. In built-upon areas inappropriate uses and excessive heights and densities of buildings have become established and are difficult to change; in such areas standards are fixed by existing conditions; in new areas they can be created. By combining platting and zoning we can prevent conditions that lead to over-crowding and insufficiency of light, sunshine, and fresh air in dwellings.

The provision of ample open space about dwellings for these purposes of health must be supplemented by ample space for recreation, especially for young people. We know that in recent years this need has become greater because the street is no longer safe for play. It should be an important part of any regional or city plan to provide adequate and properly distributed facilities for this purpose, particularly in connection with industrial housing. It is largely because of the lack of city planning that there is an insufficient and badly distributed system of parks and playgrounds.

When land is subdivided owners are compelled to set apart a certain proportion of their estates for streets and when it serves their interest this land is dedicated free to the public. In residential areas the greater proportion of these streets are too wide. This is certainly true of the area of these streets that are expensively paved, but it is even true in some cases of the actual space devoted to the street reservation. With a well-balanced street system in which each street is designed and constructed to serve its purposes, instead of being made part of a stereotyped and therefore wasteful system, considerable areas of land could be saved from the street and converted into playgrounds. But in addition to what could be gained for recreation by this saving every owner of acreage should in these days, when he subdivides his estate, be required to dedicate a percentage of his building land for playground purposes.

Therefore the most important needs of industrial dwellings that should be met by combined city planning and zoning ordinances in all areas are:

a. Provision of space about buildings, by replanning crowded areas in central districts, to secure more light, air, and sunshine in the dwellings, and, where practicable, some opportunity for gardening and recreation adjoining the dwelling.

b. Enforcement of the police power to the fullest limits that are reasonable to ensure health safety, and general welfare in connection with all building developments.

c. Control of platting so as to prevent waste of space and costly construction in streets, add to playground space, combine the services of water supply and sewerage as essential features of building sites, and limit the number of dwellings to each acre.

Other features may require attention in particular cases such as prevention of pollution of surface waters.

Many things need to be dealt with more adequately in housing codes—such as insistence on good standards of construction of dwellings in the interest of safety from fire, of proper paving and drainage adjacent to the buildings, and of ventilation and sanitation. These and the prevention of overcrowding per room are matters for regulation in housing ordinances, rather than in the provisions of the city plan. My special purpose is to deal with the latter and emphasize their distinctiveness and importance.

VI. CONDITIONS IN NEW YORK

In the New York Region we have examples of every kind of good and bad housing. We have the crowded slum areas to which I have referred. These are not only in crowded central areas but in dwellings in the small towns and villages. They consist not only of dilapidated structures erected at a time when sanitary standards were lower than at present, but of newly built houses of a defective character in regard to construction, spacing, and provision for social needs.

The housing problem in New York is intimately tied up with the transit problem. The great cost and difficulty of transporting people and of distributing food are incidental to, and part of, the cost of housing. At present the demand exceeds the supply and the problem is thereby intensified, but in times when the reverse is the case there are unhealthy housing conditions, overcrowding of dwellings, and congestion of areas.

In the New York Region we had a population of 8,979,055 and 57,753 factories in 1920. It is therefore an immense industrial region with an immense industrial housing problem. The number of employes in factories in 1920 was 1,209,447. At the rate of four persons per dwelling these would occupy 302,362 dwellings. The greater part of this population of workers lives in crowded tenements in all the five boroughs and in places over the city boundaries. A large proportion live in small frame dwellings, to some extent in Bronx and to a relatively large extent in Queens and Staten Island, and in the adjacent counties. Too small a number live near their work. The growth of the distance between the worker and his place of employment is always increasing. Congestion of subways and ever mounting burdens of taxation and cost of travel are incidents in the growth.

The New York State Commission of Housing and Regional Planning says that there is no chance of tenants getting new accommodations in New York City when they are unable to pay more than $9 a room. This means that the majority of people in New York who are not enjoying the restrictions under the rent laws are unable to get new accommodations. New York is doing well in actual construction of apartments and wooden frame houses, neither of which represent the best standards of housing accommodation. More open development is wanted where durable construction is being used and better construction where there is open development. The standards of density need to be lowered in the central areas, and those of construction need to be raised in the parts of Queens where flimsy wooden buildings are introducing what is probably the worst fire menace that has ever afflicted New York.

Indifference to the increase of congestion and overcrowding in the center and flimsy construction in the suburbs of New York may be based on the easy-going philosophy that things are not so bad as they have been in the past. But the greatest evils of these bad conditions can only be felt as they spread themselves over vast areas and can no longer be isolated in small districts surrounded by comparatively good conditions. Things that were bearable when New York was smaller are daily becoming less bearable as the city grows.

It is suggested that one of the reasons for the present difficulty is the inability to obtain funds at reasonable cost. To meet this difficulty it is proposed that funds at a low rate of interest be provided by the state.

Two things are essential in connection with any policy to fix rent by law and to provide state assistance in the matter of money:

1. If the rents are restricted, a constructive housing program should be inaugurated to prevent the necessity of retaining this artificial interference with the law of supply and demand longer than is absolutely necessary.

2. If state aid in the matter of money is considered to be essential to obtain more houses for people of small means, the funds should be controlled by an expert body and should be distributed under conditions which secure, (*a*) that such funds shall only be used for financing a supply of accommodations of a wholesome standard in regard to light, air, sanitation and surroundings; (*b*) that the benefit of any reduction in cost, as compared with the prices that would have to be paid to the usual money-lending agencies, should be returned to the community indirectly by giving to the poorest workers a better standard of accommodation than they can otherwise afford.

Such studies as I have made or seen made of housing conditions in

New York, like those in London, Berlin, and other great cities, have revealed almost a desperate attitude on the part of those who have been striving to find means of solving the problem.

When we are confronted with a problem of this kind in a great industry or in government, we start an investigation to analyze the causes of the trouble, and probably proceed to make a model so as to demonstrate how these operate and how they can be removed. In education we have discovered the immense value of the object lesson.

When we realize that housing reform in a democracy is impossible without education of the public to appreciate what the difficulties are and how they could be overcome, then we shall recognize the importance of creating an object lesson in better housing conditions.

If New York is to increase as rapidly as it is now doing, without further congestion and higher taxes to meet the cost of congestion, it is obvious that some relief must be secured by spreading the industries over wider areas. By dispersing the industries we will lessen congestion and improve housing conditions in the center; we will attract more population to the newly developed industrial area in the outskirts; and we will get rid of the necessity for much travelling. To lessen congestion does not mean lessening in any degree the economic stability of Manhattan Island or of Brooklyn as the principal business and cultural centers of the metropolis. On the contrary, it will strengthen these places if we reduce congestion to a reasonable degree of concentration and secure the break-up of uneconomical uses of the central districts.

Many industries that are carried on in the central areas might easily be carried on in the more open parts of Long Island, Westchester or New Jersey, and probably there would be a considerable movement toward dispersing these industries into open areas if the manufacturers had any assurance that their workers would be provided with housing accommodations in the event of the removal of the industry. So far as industries have moved out, they have encountered great difficulty in obtaining housing accommodations, and this has caused many to remain where they have to meet heavy expenses due to congestion and lack of room for expansion at reasonable cost. In spite of these difficulties, however, industries have moved out, as has been revealed by the investigations made under the direction of Professors Haig and McCrea for the Regional Plan of New York.

There has been no concerted movement of these industries because no organization exists to promote such a movement. Yet it is obvious that individual action by manufacturers in moving their plants from one place to another must mean that they take greater risks than if they had some opportunity open to them to act in concert with other owners of plants.

Some cities have suffered from the fact that industries have been unbalanced in the class of labor they employ. A factory that employs chiefly women needs to have factories employing men in the same neighborhood, and this is one of the difficulties which presents itself when the question of removal has to be considered.

Within recent years several small industrial communities have grown up around New York. There is no doubt that a movement which would help manufacturers to distribute their plants on more economical and more certain lines of success would be welcome, and could be financially justified.

VII. NEED OF A MODEL INDUSTRIAL CITY AS AN OBJECT LESSON

We see, then, that there is need of a constructive housing program in New York as in other cities; that such a program should take into account that what is wanted is not only, or mainly, further dormitories to be linked up with the congested lines of transit; that manufacturers are willing to move if they could get more housing accommodation in new areas; and that what the public needs above all things is an object lesson demonstrating what are the difficulties which can save the most prosperous people in the world from continuing to suffer from overcrowded housing conditions for their work people. Incidentally, such a demonstration as is last mentioned would enable all the opportunities that are available for cheapening the cost of construction to be shown. There is a great deal to be done in this direction, but much investigation and actual demonstration are needed.

I therefore come to the question of a solution of the problem. In my judgment we do not know the solution. The problem of housing and the problem of transit present such difficulties that we can only find out how to deal with them if we build a model community. This would be a city in which proper balance will be obtained between its constituent parts by reason of careful planning, and in which the values created by the community can be obtained for the community without confiscating private interests.

I have seen a model city built and have aided in putting it into practical operation in the most difficult period of its history. What is known as the Garden City of Letchworth in England is sometimes smiled at as a socialistic enterprise of small moment. As a matter of fact, it is the least socialistic of housing experiments because it depends for its success on the very qualities of individual enterprise plus reasonable collective conservation of resources, which are even more an American than a British tradition. Its coöperative features in regard to ownership of land and public utilities are precisely the features which are today employed in the great trust companies, in the apartment house enterprises that have developed in Park Avenue, and in some of the principal real estate operations around New York. That they are so managed as to prevent exploitation by forms of real estate gambling or excessive concentration of building does not mean that they are in any way lacking in sound business quality, but rather that they are at the basis of business success in many lines of activity.

The greatest merit of the Letchworth scheme, to my mind, is the fact that it has revolutionized thought in England on the subject of housing during the last twenty years. It has created standards in the matter of housing densities, in the matter of legislation to promote town planning schemes, and in the matter of land development —which have done a great deal to counteract the evil tendencies of much of the socialistic legislation that has been carried out in England since the war.

Letchworth, although carried out in England, is also an example of what needs to be done in America in the environs of either New York or Baltimore, given the proper judgment and knowledge to appreciate the difference of conditions and to proceed with proper regard to these differences. It was started as the result of a book written by a man with considerable American experience, Mr. Ebenezer Howard, who suggested the building a city on an entirely new site in which he sought to achieve the following purposes:

1. Planning of a new city on an agricultural area but with existing transportation facilities, without the hampering effect of existing urban conditions.

2. Attraction of manufacturers to such an area by reason of organized transportation facilities and provision of power, water and other utilities under an organized scheme at reasonable cost.

3. Erection of homes for workers under healthful, open conditions.

4. Conversion of the value of the agricultural estate into the value of building land, and employment of the increment in providing the economic basis for the scheme.

5. Permanent reservation of a belt of agricultural land surrounding the city.

The scheme has been hampered in its execution by lack of funds. It was started at a time when people regarded that kind of proposal as visionary, and very few were prepared to put even philanthropic funds into the movement because they doubted its social expediency. Even up to the present time the amount subscribed in ordinary shares is less than \$1,000,000, as against about \$1,500,000 authorized to be raised. This ordinary share capital is entitled to a cumulative dividend of 5 per cent per annum. Those who gave the money were distinctly warned that it might be lost and that they were making a contribution to carry out an experiment.

In spite of this, however, and notwithstanding the losses due to want of capital, 5 per cent is now being regularly paid, and a reserve fund is being created to clear off \$650,000 of arrears of dividend that accumulated during the first nineteen years of the experiment. While there has naturally been a delay in paying dividends on money which had not been invested for the sake of dividends, the company has never defaulted on the payment of interest on the whole of the loan stock provided to purchase and develop the estate. In the balance sheet for this year they show loans, etc., amounting to about \$3,000,000. There has been a continual borrowing of money and an unbroken record of payment of interest. Today it would seem reasonable for such a company to start with a capital of ten or twenty millions, and thus avoid the losses which Letchworth labored under for lack of capital.

What is the accomplishment of the Letchworth company? It has attracted about 30 manufacturers to erect their plants in the new town, and housing accommodations have been built for a population of about 14,000 people. Over 2000 cottages have been erected by housing companies and the municipality. Rents and taxes (rates) vary from 2½ to 4 dollars per room per month. The report shows that the town steadily grows. The company owns the whole of the site of the town of 4500 acres purchased at about $200 per acre, of which 1500 acres are being developed for the city. It owns the gas, electricity and water supply utilities. Its net profits for the current year, after payment of interest on loan stock and all other charges, amount to over $60,000, of which about $50,000 is required to pay a dividend on the capital stock. The value of the freehold, gas, water and electricity undertakings, may be judged from the fact that the directors have arranged an issue of $1,000,000 first mortgage debenture stock on the security of these undertakings.

There is no question that the company is working on a conservative basis. Indeed, the only serious criticism that is made against it is that it is not utilizing the great values it has created in real estate for the purpose of paying off its accumulated dividend arrears and contributing to the reduction of the cost of its public services. If the estate were sold up it would undoubtedly leave very large profits to the community over and above the cost of releasing the capital invested.

The modest but sure success of Letchworth has been possible, notwithstanding that for every one acre used for building the town, about two acres have been permanently set aside for agricultural purposes. This means that there is secured in perpetuity an agricultural belt around the town which never can be built upon. If the town grows, it must leap over this agricultural belt. Even in the town area the average density of houses does not exceed eight to the acre. Practically every home has a garden.

The town is situated so that its inhabitants may visit London to enjoy the cultural facilities of the great center. Its manufacturers have their central places of business in London, and the theaters of London provide enjoyment at a comparatively small cost to its residents. In other words, London still continues to enjoy the advantages of the gains of population of this satellite community outside its environs without having to meet the costs of educating children living in crowded tenements and transporting thousands of workers between their places of work and their homes.

It is a very small experiment—almost insignificant in physical proportions—but it has achieved its purpose of educating the people of England to understand that the housing problem cannot be solved merely by building more houses, nor the transit problem merely by providing more trains, trolleys and busses. Other model communities have been built in England including Welwyn, the second Garden City, and industrial villages like Bournville and Port Sunlight erected by large manufacturers.

Many manufacturers in the United States have promoted and carried out projects for the betterment of housing conditions and have built new villages and towns. Some of these examples have been defective as they have consisted of one-industry towns, too much under the control of the industry or employer of labor,—and in some cases suffering from paternalism.

During the war large numbers of well planned industrial settlements were created and many valuable lessons were learned. In the domain of housing for well-to-do classes, suburban communities have been created in the environs of American cities which are probably superior to any found in other countries. Roland Park, Baltimore, is an outstanding example. But in the sphere of general industrial housing, in the matter of social organization of industrial regions, the door of opportunity is still open.

As I have said elsewhere:

> We do not want reform of the system of land and housing development; we want to begin to employ system. We do not want to endanger legitimate interests in property but to establish them. We do not want to inaugurate socialistic extremes but to forestall them. We do not want to lessen liberty but to make it more widespread. And, recognizing that life is more important than property, that the aim of all production is life and not money, and that real national wealth is to be measured by the health of the people, we have either to control the right to property so that it shall not

endanger the right to live in wholesome surroundings, or face inevitable decay. Thus the practical alternatives which the modern civilized nations have apparently to face are either to apply scientific method to the control and direction of their community life, without interference with equality of opportunity for all its citizens, or to let the present parasitical and disorderly forms of industrial development continue as before—offsetting every effort made to improve the social conditions of the people.

The necessity for rapid production and increasing cost of labor have shown the manufacturers and shipbuilders that good housing, accompanied by social organization, is essential to secure efficiency and contentment on the part of labor; and the importance of good housing as a means of conserving health is fully realized in this country. The federal and state governments have begun to recognize that they have a distinct responsibility to educate the public as to how better conditions can be obtained. Large industrial trusts, like the Steel Corporation, have demonstrated their belief that housing for their workers is essential to obtain industrial efficiency. The creation of welfare departments of the national government under the leadership of Mr. Herbert Hoover and of the Housing and Regional Planning Commission of the State of New York are hopeful tendencies that should be able to influence the direction and character of housing enterprise in the future.

But without scientific investigation of the problem and the creation of an object lesson in the development of an industrial town, real progress cannot be made in promoting adequate standards of health and economic stability in industrial communities.

America, with its great wealth, with its unbalanced system of development in its great industrial centers, with the proof that exists that manufacturing plants need more room for expansion and are showing a tendency to disperse into more open areas, with vast areas of beautiful country served by means of transportation and awaiting development, with a people accustomed to great enterprises and bold action, has the power to achieve something in solving the problems of congestion and industrial housing far greater than can be achieved elsewhere. But action that will lead to progress must be based on knowledge and in this case the required knowledge can only be obtained by a great practical experiment in building a model city.

INTENSITY SURVEYS OF HOOKWORM INFESTATION

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Hookworm disease is not a subject about which the average physician or public health worker becomes very enthusiastic. Like tuberculosis at the present time, or like pneumonia, chronic nephritis or rheumatism some ten years ago, the problem seems so immense, so hopeless and so unproductive. There is so little about it to stimulate the youthful imagination of the novitiate, so few fascinating loose threads which can be seized and slowly unraveled from the knotted, hopelessly tangled skein.

The advancement of our knowledge concerning specific disease may be compared to objects floating in a mountain stream. One disease gets caught in a sluggish whirlpool and revolves slowly amid the debris for a long period as others go rushing by. Then this disease may be carried by chance to the outer rim of the whirlpool, become caught in the rush of the main stream, and go whirling downstream with foaming rapidity only to become checked in another whirlpool further down, to again sluggishly revolve in a narrow circle. Or perhaps at intervals some torrential downpour of additional scientific information carries the whole body of the stream out of its normal banks and the individual disease in the whirlpool is carried forward with all its fellows.

Hookworm disease is a "whirlpool disease," and yet logically it should be of supreme interest, for it is the most common parasitic infestation of humanity in the whole world. If we were to take a census of the world's population at this moment and catalogue all the diseases and scourges of mankind, I hazard a very good guess that the name of *necator americanus* would, like that of Abou Ben Adhem, lead all the rest.

It is the very prevalence of the disease, its lack of complexity, ease of diagnosis and simplicity of treatment which render it uninteresting.

But though one may not have the slightest interest in the disease itself, nevertheless it becomes of general interest because it is such a brilliant example of the effect of environmental factors upon the distribution of disease, some of these factors being controllable, others being beyond our power to modify in the slightest degree.

The development of our knowledge of the epidemiology of hookworm disease is a long and complex story. Napoleon once said that he preferred "a briefest possible sketch to a whole volume of explanations," so that we shall follow his dictum and sketch in only the outline. Those who first described hookworm disease and discovered its cause also clearly understood the essential factors in its prevention and cure, namely, (*a*) adequate treatment of cases to remove the causal agent, and (*b*) proper disposal of human feces to prevent reinfection. These cardinal principles have not been changed up to the present day.

It is true that the life history of the parasite was not well understood. The illuminating work of Loos in Egypt proved that the parasite entered the body through the skin, and not by the mouth, and he added one important principle of prevention, namely, the protection of the bare skin from contact with moist infested soil. But old traditions die hard and it is still difficult to convince otherwise reasonable and intelligent clinicians that at least some of the parasites do not enter by the mouth.

After Loos' work, the disease slowly revolved in a quiet pool until Doctor Stiles caught it up again and gave it new impetus. He not only discovered the disease in the United States and differentiated between *necator americanus* and *ancylostoma duodenale*, but also made a thorough epidemiological study of the disease. The general epidemiological principles developed by Dr. Stiles have not been modified up to the present time. He noted, for example, the relationship of type of soil to the distribution of the disease, determined the limits of geographic distribution as influenced by temperature, and noted that negroes were less heavily infested than whites under similar living conditions. He also observed that light hookworm infestation produced no measurable injury to the growing child.

The beginning of the work of the Rockefeller Sanitary Commission was a direct result of the studies of Dr. Stiles. The essential features of the work of this commission were:

1. Education of the people as to the cause of the disease, the mode of entry of the parasite into the body, and best methods of prevention.
2. Demonstrations of the elimination of the parasite by treatment.

The dispensary method was used—thymol was employed in treatment. Every individual having ova in the feces was considered as a case of hookworm disease, to be treated until the stools were negative. The educational campaign reached even the most remote parts of the rural sections of the Southern States and hookworms were pursued relentlessly. Sometimes individuals were given five or ten treatments to get the last remaining worm.

The sensible, clear sighted, general practitioners of the rural districts of the south were not always carried away by the general enthusiasm. They noted that many individuals diagnosed by the laboratory as cases of hookworm disease were obviously perfectly strong and well. These individuals were not suffering from anything but the over enthusiasm of the scientist who was acting upon the logical inference that the microscope could not fail.

The Uncinariasis Commission to the Orient showed that the microscope was not making mistakes but our interpretation of the results was at fault. Dr. Darling proved that one could not make the diagnosis of hookworm disease by simply finding hookworm ova in the stools, but that the important factor was the actual numbers of worms harbored by the individual, e.g., the intensity and not incidence of infestation. He developed the worm count method as a measure of the intensity of infestation. He then compared the physical condition of a group of adult prisoners having varying intensities of hookworm infestation and found that an intensity of at least 100 worms was required to produce measurable reduction in the hemoglobin of these men. This commission also showed that *ancylostoma duodenale* was much more severe in its ravages than *necator americanus.*

Now if the injury produced by hookworms is in direct proportion to the number of parasites harbored, then obviously the best method of relief would be to remove as many parasites as possible. The success of one's efforts would be measured not in terms of numbers of individuals treated but rather in the numbers of worms removed.

To produce the most efficient results, Dr. Darling developed the "standard treatment," which is one that will remove 90 to 95 per cent of all hookworms harbored, in a single administration. Once the standard treatment was determined it was possible to develop the administrative procedure of "mass treatment" in which large groups of the population are treated at one time without recourse to laboratory procedure. This method was particularly applicable in those places in the Orient where previous study had shown that a large portion of the population had so heavy an infestation as to be of real economic importance.

The Brazilian work was a continuation of the study of the intensity of hookworm infestation, using the worm count method as an index. The relationship of factors such as age, sex, color, and occupation to hookworm intensity were studied.

But the measurement of hookworm intensity by the worm count method is a very slow and laborious process and can be carried out successfully only under strict discipline such as one finds in prisons, reform schools, etc. At this critical point Dr. Stoll came forward with a very simple and satisfactory ova count method of estimating hookworm intensity. The method has been of great aid in carrying out further epidemiological studies of the disease. Meanwhile studies had been carried out concerning the life history of the larvae in the soil, investigating the favorable and unfavorable factors which influenced the free living stage of the parasite.

Before the worm count and ova count methods were developed, it was known that hookworms were prevalent throughout the tropical and sub-tropical world. These methods of estimating the intensity showed that though the distribution was widespread, nevertheless there was a marked variation in intensity of infestation within small areas, even within community or family groups.

When these investigations had reached their most interesting point of development, they received a serious check, for Sir Clayton Lane in England and Dr. Kofoid in America, among others, vigorously challenged the main premise upon which the whole structure stood. These authors felt that every single case of hookworm infestation was suffering from actual hookworm disease, even though the number of worms harbored was very small.

Before proceeding another step, therefore, it was necessary to measure the degree of injury produced by hookworm infestation. This has not yet been determined for *ancylostoma duodenale.* The workers at the field research station in Alabama have spent the past three years studying the effect of *necator americanus* upon the growing child and the remainder of this discussion refers only to areas where *necator americanus* is the infective agent.

The results are clear cut and, I believe, quite conclusive. It has been found that 100 hookworms or more produce definite mental and physical retardation in the growing child of six to eighteen years of age. This intensity of infestation we have called true hookworm disease. Infestations of 25 to 100 worms produce very slight but measurable symptoms which disappear when all or a greater part of the worms are removed. For example, there is a slight reduction in hemoglobin in these cases which returns to normal within a few weeks after treatment. Infestations of from 1 to 25 hookworms (*necator americanus*) produce no measurable symptoms and we have considered these cases as hookworm carriers and not cases of true hookworm disease. In the course of our studies we found that though there was not a village or hamlet in the entire state of Alabama which was entirely free from hookworm infestation, nevertheless true hookworm disease of severe enough intensity to be of measurable harm to the individual and economic disadvantage to the community was limited to the rural white children of school age in certain limited sections of the state. We also found that there were certain interrelated factors which influenced this distribution of intensity. Some of these factors were controllable, some beyond all human control. The interrelation of all factors in their most favorable combination produced the highest intensity of infestation, but the influence of one single unfavorable factor might make the disease impossible.

The principal factors affecting the distribution of hookworm disease are:

Controllable or remedial factors:

1. Economic conditions
2. Customs and habits of the people

3. Occupation of the people
4. Immunity—racial or individual

Uncontrollable factors:

1. Temperature
2. Rainfall
3. Type of soil—geological

To illustrate my point I shall give examples of the influence of these various factors on the distribution of hookworm disease.

a. Occupation. The professional people—lawyers, bankers, teachers, etc., do not have hookworms in the most heavily infested areas in the southern states because their occupations do not bring them into intimate contact with the soil.

b. Customs and habits of the people. In the villages and towns of the Southern States it is the custom to use some type of latrine. Thus soil pollution is not common and hookworm infestation in the towns and villages is rare.

c. Rainfall is an important factor in the distribution of the disease. In the highlands of Mexico or in central and western Texas all factors are favorable for hookworm infestation except rainfall. Sawyer has set a minimum of 40 inches of rainfall annually as the lowest rainfall at which infestation can assume economic importance. In west Texas and the highlands of Mexico there are less than 20 inches of rain, and thus hookworm disease cannot establish itself no matter how favorable other factors may be.

d. Type of soil. This is a factor of great importance and was first emphasized by Dr. Stiles. He noted that hookworm disease was most prevalent in the sandy soil of the south. The hookworm larvae must pass a part of their life in the soil and they are very sensitive. If they dry up they die. They must retreat with the ground water or perish. But if the texture of the soil is too fine they cannot retreat. In the black belt soil of the south, for example, a soil of very fine texture, the larvae cannot develop in the soil and hookworm disease cannot exist, no matter how heavily the soil may be polluted, nor how favorable other factors may be for heavy hookworm infestation.

If, then, we accept the dictum that low hookworm intensity produces no measurable injury to the individual and is of no economic importance to the community, it is obvious that the public health administrator should devote his time and attention to those communities where hookworm disease is an economic problem. It is also obvious that it is not only unnecessary but unfair to treat the hookworm carrier in order to remove the few parasites he may be harboring, for everyone must admit that there is a certain danger in hookworm treatment and we can promise the carrier no corresponding benefit.

The important argument in favor of treating the carrier is that he is a menace to his community. Theoretically this is true but if he is a case of light infestation it is a definite indication that his environment is such that factors are unfavorable to heavy infestation of himself or his neighbors. It is a general principle of public health to use treatment in alleviation of suffering and disease, and sanitation to control the carrier. We have not yet been able to discover a method of treatment of the typhoid carrier to render him less of a menace to his fellow. By education and sanitation he is prevented from infecting his fellow man.

Furthermore, by treatment of the carrier one does not change any of the fundamental factors that are producing hookworm infestation, and it is these factors that determine the level of intensity of infestation of a given community, so that though treatment of hookworm disease has a very definite place in the alleviation of suffering, treatment of the carrier is a futile waste of time, of no value to the community and of certain danger to the individual.

If we accept these general principles, then the first step in the control of hookworm infestation of any community or state is to obtain an adequate conception of the magnitude of the problem, not by determining the number of persons in an area who harbor hookworms but by determining the distribution and density of the hookworm population of the area. This we have called an intensity survey of hookworm infestation. It is really a hookworm census. A very good method of estimating the probable or potential hookworm intensity of an area is to first study the factors, favorable and unfavorable, controllable and uncontrollable, which influence the life of the parasite in the area. In order to explain this method of approach to such a study we may take as an example a hookworm intensity survey of the State of Tennessee which is just being completed. Let us approach the state as though it were a new, uncharted area that had never been considered before.

FACTORS INFLUENCING HOOKWORM INTENSITY IN TENNESSEE

1. *Temperature and rainfall.* Though the winters in Tennessee are cold there is a long warm summer with ample rainfall to produce most favorable conditions for development of hookworm larvae in the soil during four or five months of the year.

2. *Occupation.* There are many industrial centers but the state is largely rural, most of the people in the state being engaged in agriculture. Thus in a large part of the state, occupation favors infestation.

3. *Economic status.* The economic status of the rural people is such that shoes can be worn at all times but it is the almost universal custom for the children up to about fifteen years of age to go barefoot during the summer months. Thus children may be infested, though adult infestation would be rare.

4. *Sanitary customs.* In the villages and towns the pollution of the soil is rare but in the rural districts soil pollution is common.

Up to this point therefore we may deduce that hookworm infestation will be limited at least to the *rural white children of school age.* Previous studies of the southern states have shown us that negro children have a racial immunity to heavy infestation and since infestation is slowly acquired heavy infestation is rare in children under five years of age.

5. *Soil.* The state is divided into five or six geological areas. Samples of soil were taken from the various soil areas and it was found that only in the soil taken from the narrow sandy soil belt in eastern Tennessee, just east of the Appalachian Chain and in the soil from the very narrow sandy belt in west Tennessee were hookworm larvae able to develop with any degree of success. In soil samples from the remainder of the state the larvae developed with great difficulty. This is not due to unfavorable chemical nature of the soil but to a physical characteristic—texture and size of particles.

From these preliminary observations we may be sure that though rainfall, temperature, economic conditions and customs of the people are favorable for heavy hookworm intensity in the rural districts of Tennessee, nevertheless hookworm disease never did and never will, in fact could not exist in a large proportion of the state because of this one unfavorable factor—type of soil.

To check those observations, Stoll ova counts were made in selected soil areas. In east Tennessee where the soil is unfavorable for larval development, a high incidence was found because of particularly unfavorable economic and sanitary factors, but no true hookworm disease was found in this area. Incidence was high but intensity was low. In the Highland Rim and Central Basin, both intensity and incidence were very low as they were also in the western alluvial plain. Only in the sandy soil areas of the state did true hookworm disease exist.

These findings greatly simplify the problems of the administrator. Though there are some cases of hookworm infestation in almost every area in the state, hookworm disease as an economic problem will never be, in fact cannot become, important in a large proportion of the state. In certain definite geological soil areas the infestation is of serious economic import. Certain of the factors which tend to produce this heavy infestation are controllable. In these areas, then, the health officer can concentrate his efforts, alleviating suffering by administering treatment to *rural white children* of school age who show by Stoll ova count that they have an infestation of twenty-five or more hookworms. He will control the carrier and prevent reinfestation by education of the whole people and by sanitation.

Hookworm infestation which is found in those soil areas of the state that are unfavorable to larval development may be considered as purely casual and of no economic importance. With the advancement of sanitation, education of the people and improved economic conditions, this casual infestation will disappear, independently of any treatment that may be administered. These observations illustrate forcefully the important influence in our lives of the soil upon which we live. Some of you have read a remarkable book called "Growth of the Soil," written by a Scandinavian, which won the Nobel Prize in 1923. The theme of this interesting story is that the soil is not a product of man's efforts but man is a product of the soil upon which he lives. In it he has his roots, shallow or deep; from it he draws his strength. The type of soil upon which a man dwells determines his character, his ambitions, his virtues and his vices. It may mould the lives of great men who in turn determine the policies of nations. We may even speculate that the granite-ledged, shallow soil of northern New England, grudgingly yielding a parsimonious existence through dint of sheerest economy, has moulded the policy of this whole country. It seems certain that the light, moist, warm, easily cultivated, sandy soil of the coastal plain of the south has treacherously enslaved or slain its children while it pretended to nurture them.

THE ABSOLUTE AND RELATIVE VALUE OF LABORATORY PROCEDURES IN THE DIAGNOSIS OF TUBERCULOSIS

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As the remark is frequently made that the art of diagnosis has declined with the introduction of scientific tests performed in laboratories, it is perhaps of importance to inquire what has been accomplished and to review the claims from time to time.

I believe tuberculosis offers a conspicuous example of increasing efforts to devise new methods of detecting a disease. Every conceivable aid has been invoked in the realm of physics and chemistry to this end.

The insidious beginnings of infection, prolonged state of latency and intervals of progression, present a challenge to the medical scientist. The bacteriologists, physiological chemists, the serologists and cytologists have all been engaged upon the task, and progress has been made, even if far from meeting all desires.

Nor is there any present reason for the neglect of the painstaking physical examinations practiced by the trained physician. It is indeed true that the roentgen ray has immeasurably aided the physician in chest diseases. Too often it has become the sole criterion with many clinicians. No single discovery in the past twenty-five years has, in my opinion, performed such wonderful service in tuberculosis as the x-ray. Under our present standards for diagnosis and treatment the x-ray is indispensable.

But I would only mention the x-ray in passing, and will discuss the present status of other means used for tuberculosis diagnosis. They may be grouped roughly into three classes:

1. Bacteriological
2. Biochemical or biophysical
3. Cytological

DIAGNOSIS BY BACTERIOLOGICAL MEANS

It is apparently self-evident that the demonstration of unmistakable tubercle bacilli furnishes the most important criterion of tuberculosis that we can have. I am not aware of any instance where this has been disputed on medico-legal grounds.

The question is one, however, that will probably come to the fore from time to time when restrictions are likely to gradually increase and hedge about the tuberculous individual as the disease decreases. No one would seriously have questioned the infallibility of a diagnosis twenty-five years ago, based on the discovery of acid-fast bacilli in the sputum. Today, in the light of knowledge of non-pathogenic acid-fast bacilli, some clinical bacteriologists go no further in their statement than to mention "acid-fast bacilli present," without indicating their nature or origin. This is an ultra scientific position, but it is theoretically sound. We need only to reflect that non-pathogenic acid-fast organisms have not infrequently been found in the secretions and excretions of the human and animal bodies. Mistakes in diagnosis from this cause have been made.

It will be of interest here to go into the question of the reliability of our diagnostic methods as performed in the laboratory. It can be but a farce and an occasion for malpractice suits, if the busy clinician after a superficial examination, depends upon an equally superficial laboratory examination. More than that, the charlatan can step in and discredit scientific medicine by curing an incurable disease that did not exist. These instances are not altogether rare. On the other hand, many negative results of examinations of sputum, urine and exudates give a false feeling of security which is only human to share with the patient. Moreover, they come back to plague the over-confident physician.

Sputum examination. The sputum examination, being the most frequent and important of all the laboratory aids in tuberculosis, deserves most careful scrutiny to make it reliable. The bacteriologist must have at the start better coöperation from the physician or patient than is usually the case in collecting specimens of sputum. The bottle or other container can be made above suspicion only by cleaning with caustic soap and acids. Acid-fast bacilli may possibly be present in the hay in which the glassware has been packed. Even cork stoppers may be contaminated or the distilled water used for rinsing the bottles, may contain them.

The written or printed instructions for collecting sputum fail to be observed not infrequently, and especially where the patient will not admit raising sputum. Nasal or pharyngeal mucus will be presented with the declaration that this is all that can be produced, yet an intralaryngeal examination may reveal particles of pus on the tracheal wall. In such cases it is wiser to refuse the examination of the specimen until several days' accumulation has been made. It may even be necessary to swab the larynx or collect feces where sputum is being swallowed. This is true of children and many women.

The presence in the pharynx of tubercle bacilli and other acid-fast bacilli that have been inhaled with dust, or taken into the mouth with food such as milk, butter, cheese or cream, is conceivable. The use of old slides has also caused trouble. Therefore, an isolated bacillus or two cannot be held sufficient for a diagnosis without confirmation by further examination, culture, inoculation, or other evidences of disease in the subject.

Occasionally there are acid-fast organisms continually present without discoverable cause, or they may be traced to nasal ozena, tonsillar crypts, or sinusitis.

Animal inoculation is here the ultimate test, as in all doubtful microscopic evidence. There are instances of malingering in which insurance or pensions are involved, or where for other reasons a positive diagnosis is desired.[1] Obviously, the sputum of such cases must be collected in the presence of a witness and the container must also be controlled or certified. Smears made of such specimens should be preserved if positive and the slide etched for identification. Animal inoculation will be a further safeguard.

It is well to recognize that no dependence can be placed upon the morphology alone in the differentiation of acid-fast bacteria.

The tubercle bacillus is sufficiently characteristic to the experienced eye in routine practice, but where other evidences of tuberculosis are lacking, inoculation is again needed.

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[1] To escape military duty, to avoid unpleasant home conditions, or to obtain sympathy and attention.

Direct culture of the bacillus is readily possible after the use of homogenising methods and where time permits.

Sputum may be dissolved in 4 per cent NaOH, centrifugated and after washing, the sediment smeared on Petroff's gentian violet egg medium slants. Growth appears in ten to fifteen days in the large proportion of positive sputum cases.

The nonpathogenic acid-fasts do not resist antiformin and other homogenising methods as do the true tubercle bacilli—hence sedimentation is of use in differentiation even without culture or inoculation.

Unstained tubercle bacilli. Doubtless some microscopically negative sputum contains living but unstained tubercle bacilli. The usual Ziehl-Neelsen stain may fail. Prolonged staining in the cold raises the number of positive specimens. The iodin treatment as used in Much's method will, rarely, bring into view beaded bacilli otherwise unstained.

The administration of potassium iodide to temporarily increase the amount of sputum has occasionally been successful in bringing out bacilli.

A marked focal tuberculin reaction is another but less desirable method of accomplishing this end.

Other ingredients of tuberculous sputum have little value in diagnosis. Elastic tissue and cheesy particles are fairly characteristic, but must be distinguished from food particles, so cannot aid in the diagnosis of earliest cases.

Decolorization of smears. Insufficient decolorization of smears has in my opinion caused most of the errors in the laboratory diagnosis of tuberculosis. It is sometimes due to weak reagents (old stain, acid, or alcohol) but mostly to thick smears or particles of charred sputum or wood fiber. Scratches in the glass, particles of food saturated with oil, cheesy substances, or any vegetable material soaked with grease may simulate bacilli. Other forms of bacteria in the sputum may become impregnated with oil or may hold the stain quite tenaciously.

Technicians who report "few bacilli in many fields" or "Gaffky Scale I" require careful checking and confirmation of the report by inoculation.

A recent instance where a hospital technician reported "7 bacilli on one slide but none on three others" illustrates a type of laboratory technique requiring explanation, especially when, as in this case, subsequent examination of sedimented forty-eight-hour accumulations were negative. Such a situation is worse confused by the possibility that a few bacilli may be present and then disappear for days or weeks, or even permanently. This fact also illustrates the importance of saving specimens until the findings are verified. The responsibility is clearly serious when a diagnosis may narrow down to a positive or negative sputum. Public health as well as private laboratories can devise a system of checks which will insure safe reports, for the positive sputum examination is far and away valuable above other evidences of tuberculosis derived from laboratory tests in common use.

The negative sputum can mean little to the bacteriologist unless many successive specimens sedimented, inoculated and possibly cultivated have revealed nothing. The value of one positive is absolute when all the conditions of control are fulfilled, but obviously this is untrue of any negative result. One must consider even repeated negative specimens only important when related to other confirmatory evidence. A negative inoculation test in guinea-pigs is undoubtedly of great value in excluding tuberculosis, yet if the bacilli are dead, or of low virulence and very scanty, they may be unable to cause perceptible infection. For this reason animals should be retained for months or subinoculations made together with intradermal tuberculin tests on them at intervals. If tuberculous lesions are found they should be clearly traced to the site of inoculation.

Urine test. In the microscopic examination of urine for tubercle bacilli, all the fallacies in connection with the sputum must be considered. The chance of contamination of the receptacles with sputum and with sputum-soiled hands must be thought of in specimens not obtained by catheter. Negative smears in urine sediments may be due to lack of a fixative on the slide. The chief source of trouble is the smegma bacillus which even when strongly decolorized may simulate the tubercle bacillus.[2] The further fact has been stressed recently that renal tuberculosis may be due to the avian type of bacilli in a few cases. Inoculation of such urine sediments fails to infect guinea-pigs, which are insusceptible to the avian bacillus. The culture of the sediment after antiformin or NaOH may aid in identification of the strain; or better, the inoculation of rabbits, pigeons or fowls. The question of the possible excretion of the tubercle bacillus without disease of the kidney is debatable. It may be doubted except in acute disseminated disease. Yet they have been found when no other evidence of disease was present.

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[2] In a series of 1324 routine urinalyses during the past year at the Saranac Laboratory, 15 specimens showed acid fast bacilli present but all failed to infect guinea pigs. Fourteen specimens were from women.

The cellular elements are of little significance except that when pus without other bacteria is present, tuberculosis may be suspected. Contaminated urine may safely be inoculated after the sediment is treated with antiformin.

Blood. Microscopic examination of laked blood reveals tubercle bacilli so seldom that it has not found favor as a means of diagnosis. One reason is undoubtedly the extremely few bacilli in the peripheral blood at any given time. The inoculation of such small numbers may be without result; moreover, without inoculation the identification of a few acid-fast rods may be difficult. Fragments of blood cells are difficult to decolorize and a long search is required. Direct culture of the bacillus has been successful in the hands of Clough[3] and should be tried further. The search for bacilli in the blood may assist in determining miliary tuberculosis where other methods of diagnosis fail. Further improvements in technique are still possible, and especially the examination of pooled blood taken in small quantities at short intervals.

Feces. The discovery of tubercle bacilli in the feces has no particular diagnostic value in pulmonary tuberculosis with open lesions. When no sputum can be obtained it may aid materially to examine the stools, as for example in the insane, and in those who refuse to expectorate or who deny having any sputum. Occasionally in children, open tuberculosis may be demonstrated in this way.

The excretion of tubercle bacilli into the intestine without ulceration of the gastro-intestinal tract has been experimentally proved, yet I know of no case where a satisfactory diagnosis has been made by a microscopic examination of the feces alone under such conditions. The numbers are too few and the dilution great. Inoculation or culture of feces dissolved and sedimented by the use of caustic soda as in Petroff's method has proved successful. Nonpathogenic acid-fast organisms are fairly frequent in feces.

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[3] Clough, M. C.: Amer. Rev. Tuberc., Vol. I, 598.

The microscopic examination of feces for the diagnosis of intestinal tuberculosis is chiefly valuable for the demonstration of mucus, pus and blood, the x-ray being superior in the recognition of the location of the ulceration.

The use of a duodenal tube for collecting bile has been advocated and successfully applied in a few cases where the sputum was negative.[4]

Spinal fluid. No question can be raised as to the definite meaning of acid-fast bacilli when found in the spinal fluid. Assuming a well controlled technique, the evidence is convincing. The trouble in these examinations is in the negative results, owing to the scanty number of bacilli in the fluid.

Exudates. The difficulty of demonstrating tubercle bacilli in pleural exudates has led most laboratory workers to rely on inoculation. The common experience has been that a positive inoculation may be produced when careful search with the microscope fails to reveal bacilli.

The explanation given, which is perhaps plausible, is that only granular forms as described by Much are present. This is also true of joint fluids, pus from suppurating lymph-nodes and from cold abscesses anywhere.

The use of digestants, pepsin (inoscopy) or antiformin and sodium hydrate combined, to dissolve fibrinous clots, shreds of tissue and pus, assists materially in the sedimenting of exudates.

Tissue. The crushing and digestion of bits of skin, mucous membrane or granulation tissue removed for diagnosis give good results for staining or inoculation.

Both antiformin and sodium hydrate destroy the contaminating bacteria, and the differentiation of tuberculosis from leprosy is not called for ordinarily. Suspected skin nodules, lymph nodes, and tuberculids may be inoculated at times with positive results.

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[4] Freed, H., and Black, L. T.: Amer. Rev. Tuberc., 1923, VII, 174.

DIAGNOSIS BY BIOCHEMICAL MEANS

Tuberculin. Following the discovery of the bacillus came tuberculin in 1890, before the general adoption of the microscopic examination for the demonstration of bacilli.

It is justifiable to say that no other means is more searching and delicate in disclosing any infection than tuberculin in tuberculosis. The history of its use and abuse cannot be reviewed here. At present I would describe its diagnostic employment for two objects:

1. To confirm or to exclude the presence of tuberculous infection, past or present.
2. To produce a focal reaction at the site of suspected disease.

Infection. In this the various cutaneous tests are very useful, but the intradermic is the one of choice.

Definite reactions from the smaller doses, well controlled, are only seen when infection is present. In proportion to the age of the individual the significance lessens as proof of recent infection. Repeated negative results do not infallibly exclude infection, but when supported by negative subcutaneous tests leave but one conclusion, viz., that whatever infection has existed in the past is suppressed by complete encapsulation, or has left no trace.[5] This is supported by the experience of Brown and Heise[6] in 324 cases.

Focal reaction. To produce a focal reaction for diagnosis is extremely useful in skin, eye and joint disease. The usefulness of tuberculin in suspected genitourinary and pulmonary disease has been debatable, chiefly on the ground of danger. No doubt during a focal reaction bacilli can be mobilized. Experimentally this has been proved (Rabinowitsch[7]). Furthermore the possibility of a closed focus being brought to ulceration has to be considered. Experience has not borne out the fears held by some clinicians, and so far as pulmonary disease is concerned the results at the Trudeau Sanatorium have been uniformly favorable.

The numerous modifications of tuberculin and methods of application have not proved superior to the old tuberculin administered as previously mentioned.

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[5] The transient anergic conditions due to complications or terminal disease are of course to be considered.

[6] Brown, Lawrason, and Heise, Fred H.: Amer. Rev. Tuberc., 1920, IV, 254.

[7] Rabinowitsch, L.: Berlin klin. Woch., 1913, Nr. 3.

Tuberculin has also been used to provoke reactions to the complement fixation test with some success at the Trudeau Sanatorium.

A discussion of the use of tuberculin in prognosis is not included here, but nothing important has been developed.

BIOPHYSICAL TESTS: AGGLUTINATION; PRECIPITATION; COMPLEMENT FIXATION, ETC.

I will now turn to the biophysical reactions that have been made use of in attempts to diagnose tuberculosis.

It is a disappointment to many that with the unceasing efforts of an army of workers so little progress has been made in a useful method for the serologic diagnosis of tuberculosis. More than a thousand references may be found in the literature on this subject.

A little reflection will, however, remind us that with such a universally prevalent infection we require only to detect the presence of a recently active pathological process, which the too delicate tuberculin reaction cannot do satisfactorily. The effort has been diligently made to accomplish this and not without some degree of success.

Agglutination. In 1898 the agglutination test was introduced by Arloing and Courmont.[8] It failed to distinguish the sera of the tuberculous from apparently normal sera, and thus has been of little value.

Numerous antigens have since been tried with no better results for diagnosis, and their interest lies chiefly in the study of immune reactions.

Precipitation tests have also fared but little better, though less prone to give false reactions. In recent years the test has been revived by the introduction of more sensitive antigens. Among the ones that have received some attention are those of Fornet[9] with ether-extracted and crushed bacilli; by de Cristina and Leone[10] with chloroform-extracted, alternately frozen and thawed bacilli; and by

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[8] Arloing, S., et Courmont, P.: Compt. rend. Acad. d. Sci., 1898, 126, 1319, 1398, 1550.

[9] Fornet, W.: Deutsches Archiv f. klin. Med., 1922, Bd. 138, 229.

[10] de Cristina and Leone: Weichardt's Ergebnisse, 1924, VI.

Larson[11] with "exploded" bacilli released from carbon dioxide pressure; by Laidlaw and Dudley[12] and Mueller[13] from the alcohol precipitate from tuberculin. The reactions in normal sera are claimed to be not over 5 per cent; but are 95 per cent in tuberculous sera by the use of the first named antigens.

As a measure of clinically active disease it has not been sufficiently easy to differentiate arrested from progressive disease by these reactions to make them reliable.

Complement fixation. Even before the Bordet-Wassermann test was brought into use for lues, the method was applied in tuberculosis and has been known for twenty-five years. Widal and LeSourd, and Camus and Pagniez experimented with it in 1901.

In the Saranac Laboratory in 1902 we made use of the method in the study of immunity and to a small extent clinically.

Little progress was made until more careful study of antigens was carried out, especially by Calmette, Petroff and Besredka. Within the past three years an important advance has been gained in obtaining delicate reactions by Wadsworth and Maltaner,[14] by the use of purified antigens.

With constant study a higher percentage of positive reactions has been obtained in tuberculosis and fewer among normal sera and those of other diseases. The most important source of confusion is with luetic sera, especially where the tubercle bacillus antigens used contain much lipoid substance, as in those grown on Besredka's egg media.

Therefore it is advisable in all cases to do a Bordet-Wassermann test simultaneously to exclude luetic reactions, where the tests are employed for diagnosis. Leprosy is another exception.

At present it is possible to say that 85 per cent of tuberculous sera of all stages of the disease will give a reaction with the purified extracts of the bacilli made with water, glycerol, methyl alcohol or the dialyzed filtrate of liquid cultures.

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[11] Larson, W. P., et al.: Proc. Soc. for Exper. Biol. and Med., 1922, Vol. 19, 359.

[12] Laidlaw and Dudley: Brit. Jour. Exper. Path., 1925, VI, 197.

[13] Mueller, J. H.: Jour. Exper. Med., 1926, XLIII, 1–13.

[14] Wadsworth, A., and Maltaner, F. and E.: Jour. Immunology, 1925, X, 241.

The absolute specificity of the reaction is still subject to many factors difficult to control, both technical and possibly biophysical.

The much abused expression, "serum antibody," has too long conveyed a meaning no longer consonant with the conception of immunity. The most that we can honestly hold to in our views of the serum reactions in tuberculosis, is that the reactions between the bacillus and tissues, plus reactions between the living and dead tissues, produce more or less specific alterations, recognizable by physico-chemical tests.

With this understanding we can appreciate that there must be a threshold before which the insidious development of the infection may not show itself in the blood by relatively coarse reactions. A negative result will therefore be of doubtful value. Furthermore, having once developed in a pronounced way, the reaction can persist long after outward symptoms cease, as analogy with tuberculin reactions teaches. That no close parallelism obtains between these two tests is well known, but the fact that the complement fixation reveals changes in the circulating blood, rather than latent reaction phenomena in the other tissues makes it of greater clinical value, because it must indicate absorption from the reacting tissues.

The interpretation of a positive reaction is however to be made with caution both in diagnosis and prognosis—and a single test is insufficient for diagnosis; because with few exceptions the perforformance of the test requires a closer watch on technical details than any other routine laboratory measure. Under these limitations its use is restricted, but it can be advocated as valuable.

The diligent search for other serologic reactions than those before mentioned has brought forth little of value. Some are confirmatory in diagnosis, but most are nonspecific reactions. Brief mention can be made of the more important ones:

The Opsonic Index test of Wright (1904) was possibly the most ingenious and at the same time the most complicated test ever devised for measuring reactions of a biological nature, but it is, like the *alexin*, or *complement fixation*, applicable only in observations of the course of a disease rather than in diagnosis. The variations are too great for the interpretations to be of any value.

The viscosity test was introduced by Csépai and Torday[15] in 1911. The viscosity of the serum of tuberculous patients when mixed with bacillus antigen was found increased and when measured by the stalagmometer, readings over 4 were significant.

The estimation of the *serum lipase* by Woolley[16] and Frisch[17] showed a diminution of this ferment corresponding to the advance of the disease.

The determination of *serum protease* and *anti-protease* has not been rewarded by results of practical importance, nor have specific *lysins* for the tubercle bacillus been demonstrable *in vitro.*

Erythrocyte sedimentation and globulin tests. The more recent tests for sedimentation of the erythrocytes (Faraeus[18]) and serum globulin (Matèfy[19]) are dependent on the physical phenomena governing the rapidity of sedimentation. Levinson[20] has shown that these reactions are correlated with an increase in fibrinogen in the blood plasma and are present in acute febrile conditions from any cause. Consequently the determination of the velocity of sedimentation and the fibrinogen content are useful chiefly in registering the severity of active tuberculosis.

The flocculation reactions as introduced by Meinicke[21] and Daryâni[22] are based on the observation that the colloidal lability of the blood is greater in active tuberculosis on the addition of dilute alcohol and other coagulants, so that precipitation is more rapid.

It has been observed that there is no parallelism between these sedimentation and precipitation reactions and the complement fixation or tuberculin reactions. This fact reveals the difference between non-specific alterations in the body tissues produced by disease and those reaction changes only detectable by specific antigens. Of these we have seen the tuberculin and complement fixation reactions are the most sensitive.

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[15] Deutsche med. Woch., 1911, Bd. 37, 1476.

[16] Woolley, J. S.: Amer. Rev. Tuberc., 1924, IX, 32.

[17] Frisch, A.: Beitr. z. Klin. d. Tuberk., 1921, Bd. 48, 15.

[18] Faraeus, R.: Biochem. Zeitschrft., 1918, Bd. 79, 355.

[19] Matèfy, L.: Med. Klinik, 1923, Nr. 21, 725.

[20] Levinson, S. A.: Jour. Immunology, 1923, VIII, 183.

[21] Meinicke, Beitr. z. Klin. d. Tuberk., 1920, Bd. 46, 1.

[22] Daryâni, J.: Deutsche med. Woch., 1922, Bd. 48, 553.

BIOCHEMICAL TESTS

Little may be said concerning chemical changes accompanying tuberculosis. They are not notable and have not aided in diagnosis to any degree thus far.

Sputum albumen test. The albumen reaction is present in any purulent sputum and thus of little importance. Protein decomposition substances such as amino acids, tryosin and tryptophan are found in sputum of advanced cases but are not specific.

Lung sand or *lung stones* are more certainly from old tuberculous foci and may break through the bronchial wall with no active disease focus present or bacilli excreted with them.

The diazo and urochromogen reactions in the urine are relatively of little value, being found in other acute diseases.

Spinal fluid sugar determinations compared with blood sugar have recently proved valuable in differentiating tuberculous from other meningeal disease. The percentage is considerably less in tuberculosis, and is increased in other diseases such as encephalitis.

The mineral content of the blood is so little changed in tuberculosis that no significance can be associated with its fluctuations.

Antigen tests. Attempts to demonstrate *tuberculin* or *antigen* in the serum, urine and tissues of tuberculous individuals have been made by means of cutaneous tests and complement deviation. The results have been conflicting. Tuberculous tissues can be shown to contain antigen and also the blood, when precipitated by alcohol and a concentrated extract made, gives skin reactions. Theoretically specific products of the bacilli should be present in the circulating blood at times of active progress of the disease.

The auto-urine tuberculin test of Wildbolz[23] although demonstrable by Enright and Rettger[24] as due to specific antigen in the urine, involves a tedious process in its preparation that limits its usefulness. Further experience will be needed to indicate its value in the diagnosis of obscure cases of tuberculosis.

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[23] Wildbolz, H. O.: Corr.-Bltt. f. Schweiz. Aertze, 1919, p. 793.

[24] Enright and Rettger: Amer. Rev. Tuberc., 1924, X, 78.

CYTOLOGIC DIAGNOSIS

The exhaustive study of the blood and secretions has disclosed no *specific* cell changes in tuberculosis. The Arneth method of grouping leukocytes shows a relation of symptoms to the number of nuclei, increasing or decreasing with the improvement or retrogression. The cell counts are not materially changed, or, if so, not significantly. The presence of lymphocytes in pleural, spinal and joint fluids with a paucity of polynuclears is the most significant finding associated with tuberculosis. In the spinal fluid a relatively high lymphocyte count may give a strong presumption of the presence of tuberculosis.

In differential counts relatively more lymphocytes are found, both in the blood and sputum.

Other blood changes, such as the hemoglobin index or erythrocyte count, coincide with the stage of the disease for the most part.

In tissue sections caseous tuberculous foci are sufficiently characteristic, but it must be remembered that giant cells are not specific for tuberculosis.

CONCLUSIONS

In conclusion one is compelled to resort to the three most important tests thus far known:

1. The demonstration of tubercle bacilli.
2. The use of tuberculin tests.
3. The complement fixation test.

While other methods give some information of value for diagnosis, our main dependence at present appears limited to them and prognosis is best relegated to the clinician.

BODY BUILD AND LONGEVITY

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The conviction that body build affects longevity has been general for a long time. The very expression "well built" has become a part of our language. It implies that persons of a particular build or structure are better coördinated or somehow can function better than other people and may, therefore, be expected to have a greater life span. Variations in the structure of individuals are marked and serve to distinguish fairly definite types. Insurance experience has crystallized into a number of fairly definite conclusions with regard to the relative longevity of certain of these types. Extremes of stature, for example, are decided handicaps. Extreme overweight and underweight carry with them increased mortality and correspondingly shorter life. Very heavy people are more likely to succumb prematurely to such conditions as diabetes, organic heart disease, renal impairment, hardening of the arteries, and very light persons, particularly at the younger ages, are more likely to develop tuberculosis. Insurance experience has confirmed the popular judgment that the individuals who approach the mean of these body measures are better able to withstand the hazards of life and to round out a fairly full expectation.

Another observation of great importance is that certain measures of the human body such as, stature, body surface, weight, height sitting, chest measurement and vital capacity, are closely related in their variability. In our current terminology, we say that they are highly correlated, some pairs being more closely related to each other than others. As long ago as 1846, Dr. John Hutchinson considered some of these relationships and especially those existing between standing height, weight, circumference of the chest, and the vital capacity. More recently, Dreyer of Oxford, following up the clues of Hutchinson, thought he could establish definite norms of build and relate these to physical fitness. Dreyer developed a number of formulae which he believed expressed the relationship between each of the four measurements, weight, height sitting, chest girth, and vital capacity, among healthy people, and in his final work, he presented a series of tables in which he gave the values of these measurements in terms of each other for presumably healthy lives.

Those who are interested in my critique of the work of Dreyer will find it in the *Journal of the American Statistical Association* for June, 1922. I may here briefly state that we were not able to confirm the relationships which Dreyer thought existed between the four bodily measurements in healthy persons. His observations were based on too few individuals, and he made what I consider to be the fatal mistake of assuming that his subjects were fit merely on their appearance of good health and not on the really determining fact of their subsequent length of life. Others in our country have attacked the several problems introduced by Dreyer and have found similar difficulties both with his method and with his findings. Nevertheless, Professor Dreyer did anthropometry and scientific medicine a great service in raising the question as to whether there were not certain very definite types of build associated with greater or less longevity. The specific problems arising out of this programme of Dreyer's are very many and will keep investigators busy for many years.

I have already intimated that the experience of the life insurance companies has shown that overweights as a group have a below-average duration of life. Generally speaking, it has been the custom of the medical directors of the life insurance companies to be guided in their selection of risks by a table of average weights which was constructed from the heights and weights of a large number of persons insured on standard policies. Their practice has been to consider as normal, weights within a range of 20 per cent above and 20 per cent below the average. Beyond these limits, applicants for insurance were considered as possibly subnormal as to build and expected to give a higher mortality, depending upon the extent of the departure from the average weight. The Standard Table of Heights and Weights for Men prepared for and published in the reports of the Medico-Actuarial Investigation conducted jointly by the Actuarial Society of America and the Association of Life Insurance Medical Directors is shown herewith.

Standard Table of Heights and Weights

MEN

Light-face figures are 20 per cent under and over the average

HEIGHTS		WEIGHTS ACCORDING TO AGE PERIOD								
Feet	Inches	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59
4	**11**	89 **111** 133	94 **117** 140	98 **122** 146	100 **125** 150	102 **127** 152	104 **130** 156	106 **132** 158	106 **133** 160	107 **134** 161
5	**0**	90 **113** 136	95 **119** 143	99 **124** 149	102 **127** 152	103 **129** 155	106 **132** 158	107 **134** 161	108 **135** 162	109 **136** 163
	1	92 **115** 138	97 **121** 145	101 **126** 151	103 **129** 155	105 **131** 157	107 **134** 161	109 **136** 163	110 **137** 164	110 **138** 166
	2	94 **118** 142	99 **124** 149	102 **128** 154	105 **131** 157	106 **133** 160	109 **136** 163	110 **138** 166	111 **139** 167	112 **140** 168
	3	97 **121** 145	102 **127** 152	105 **131** 157	107 **134** 161	109 **136** 163	111 **139** 167	113 **141** 169	114 **142** 170	114 **143** 172
	4	99 **124** 149	105 **131** 157	107 **134** 161	110 **137** 164	112 **140** 168	114 **142** 170	115 **144** 173	116 **145** 174	117 **146** 175
	5	102 **128** 154	108 **135** 162	110 **138** 166	113 **141** 169	115 **144** 173	117 **146** 175	118 **148** 178	119 **149** 179	120 **150** 180
	6	106 **132** 158	111 **139** 167	114 **142** 170	116 **145** 174	118 **148** 178	120 **150** 180	122 **152** 182	122 **153** 184	123 **154** 185
	7	109 **136** 163	114 **142** 170	117 **146** 175	119 **149** 179	122 **152** 182	123 **154** 185	125 **156** 187	126 **157** 188	126 **158** 190
	8	112 **140** 168	117 **146** 175	120 **150** 180	123 **154** 185	126 **157** 188	127 **159** 191	129 **161** 193	130 **162** 194	130 **163** 196
	9	115 **144** 173	120 **150** 180	123 **154** 185	126 **158** 190	130 **162** 194	131 **164** 197	133 **166** 199	134 **167** 200	134 **168** 202

Standard Table of Height and Weights—Continued

HEIGHTS		WEIGHTS ACCORDING TO AGE PERIOD								
Feet	Inches	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59
	10	118	123	126	130	134	135	137	138	138
		148	154	158	163	167	169	171	172	173
		178	185	190	196	200	203	205	206	208
	11	122	126	130	134	138	140	142	142	143
		153	158	163	168	172	175	177	178	179
		184	190	196	202	206	210	212	214	215
6	0	126	130	135	139	142	145	146	147	148
		158	163	169	174	178	181	183	184	185
		190	196	203	209	214	217	220	221	222
	1	130	134	140	144	147	150	152	153	154
		163	168	175	180	184	187	190	191	192
		196	202	210	216	221	224	228	229	230
	2	134	138	145	149	153	155	158	158	159
		168	173	181	186	191	194	197	198	199
		202	208	217	223	229	233	236	238	239
	3	138	142	150	154	158	161	163	164	165
		173	178	187	192	197	201	204	205	206
		208	214	224	230	236	241	245	246	247

For a long time, there has been the suspicion among insurance executives that there were in fact several types of overweights and that these would show different mortality experiences. Chest as compared with abdominal girth, and especially the length of the spine have been considered important characters which might determine the mortality of overweights. Or, to put it more definitely overweights with large chests and long trunks have been expected to show a much more favorable subsequent mortality than those with a relatively narrow chest and short trunk. In a number of companies, overweights have been selected on this basis for some time. To determine the truth of these suspicions, a Committee of the Association of Life Insurance Medical Directors was appointed to study the question, and the problem was assigned to my office for investigation. Fortunately, the Union Central Life Insurance Company of Cincinnati had for many years recorded the length of the spine for all of its applicants for insurance, together with the other body measurements that are usually taken, total height and weight, chest and abdominal girth, etc. There thus became available for this investigation the very complete records of more than 38,000 overweights, together with their subsequent survival history, covering the period of years from the date of their entry between 1887 and 1907 to the anniversary of their policies in 1922. Here was obviously the material necessary for the solution of the question whether this particular character, that is, the length of spine, either alone or in combination with other body measurements, played a part in determining the subsequent mortality of overweights.

TABLE I

Number of overweight men in specified build and height classes, Union Central Policy Issues, 1887 to 1907

BUILD CLASS	ALL MEN		SHORT MEN		MEN OF MEDIUM HEIGHT		TALL MEN	
	Number	Per cent of total overweights	Number	Per cent of total overweights	Number	Per cent of total overweights	Number	Per cent of total overweights
All overweights	38,062	100.0	6,567	100.0	22,888	100.0	8,607	100.0
Build class:								
I	25,932	68.1	4,390	66.8	15,866	69.3	5,676	65.9
II	9,494	24.9	1,670	25.4	5,560	24.3	2,264	26.3
III	2,323	6.1	450	6.9	1,279	5.6	594	6.9
IV	304	0.8	55	0.8	180	0.8	69	0.8
V	9		2		3		4	

Table 1 presents the facts for the constitution of this group of 38,062 overweight men according to build-class. Class I consists of those who showed an excess of 16 pounds and less than 32 pounds over an assumed norm; Class II, an excess of 32 pounds and less than 48 pounds; Class III, 48 pounds and less than 62 pounds; Class IV, 62 pounds and less than 78 pounds and Class V, 78 pounds or more in excess of the assumed norm. More than two-thirds of the overweights were in Class I, approximately one-fourth were in Class II, and Class III contained a little more than 6 per cent of the total. Classes IV and V were negligible for our purposes. These proportions, moreover, did not vary markedly in each one of the three sub-groups of short men, men of medium height and tall men.

We next computed for each of our height-build classes the average relative spine length, that is, the percentage spine length of total height. The following table 2 shows these averages vary but little from 37 to 38 per cent of the total height. The standard deviation from the average for each one of the build groups is, moreover, close to three units. This classification makes it possible to divide each one of the height and build groups into three parts: first, those who are within the limits of the standard deviation, plus and minus, from the average spine length; second, those whose spine length is above the standard deviation from the mean spine length; and third, those below the standard deviation from the mean spine length. The first of these three classes are obviously those with average spines, the

TABLE 2

Characteristics of relative spine length (percentage spine length of total height) for overweight men in respective build classes according to height groups

CHARACTERISTICS; BUILD GROUP	HEIGHT GROUP		
	Short men	Men of average or medium height	Tall men
Mean relative spine length:			
Build group:			
All overweights	37.650 ±0.026	37.404 ±0.013	37.131 ±0.021
1	37.493 ±0.031	37.268 ±0.015	37.033 ±0.025
2	37.948 ±0.052	37.661 ±0.026	37.242 ±0.042
3	38.022 ±0.101	37.821 ±0.053	37.544 ±0.079
4	37.991 ±0.293	38.469 ±0.145	37.878 ±0.237
5	*	41.100 ±3.312	38.800 ±2.551
Standard deviation:			
Build group:			
All overweights	3.080 ±0.018	2.867 ±0.009	2.873 ±0.015
1	3.030 ±0.022	2.872 ±0.011	2.835 ±0.018
2	3.146 ±0.037	2.825 ±0.018	2.950 ±0.030
3	3.183 ±0.072	2.824 ±0.038	2.868 ±0.056
4	3.225 ±0.207	2.887 ±0.103	2.925 ±0.168
5	*	8.505 ±2.342	7.564 ±1.804

* Only two cases in classification.

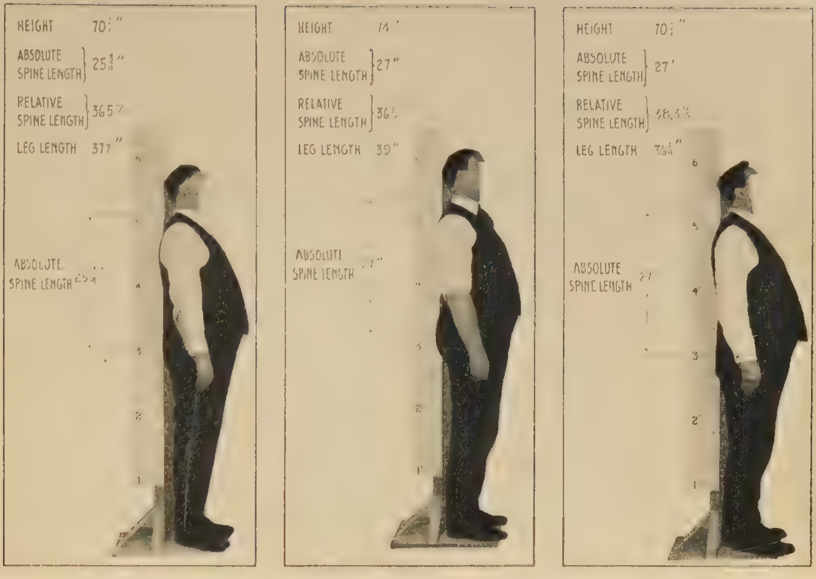
HEIGHT 70½"
ABSOLUTE SPINE LENGTH 25⅝"
RELATIVE SPINE LENGTH 36.5%
LEG LENGTH 37⅞"
ABSOLUTE SPINE LENGTH
HEIGHT 74"
ABSOLUTE SPINE LENGTH 27"
RELATIVE SPINE LENGTH 36%
LEG LENGTH 39"
ABSOLUTE SPINE LENGTH
HEIGHT 70½"
ABSOLUTE SPINE LENGTH 27"
RELATIVE SPINE LENGTH 38.3%
LEG LENGTH 36½"
ABSOLUTE SPINE LENGTH 27
6
5
4
3
2
1

Plate A. Tall men, overweight on standard table, with increasing absolute or relative spine-lengths.

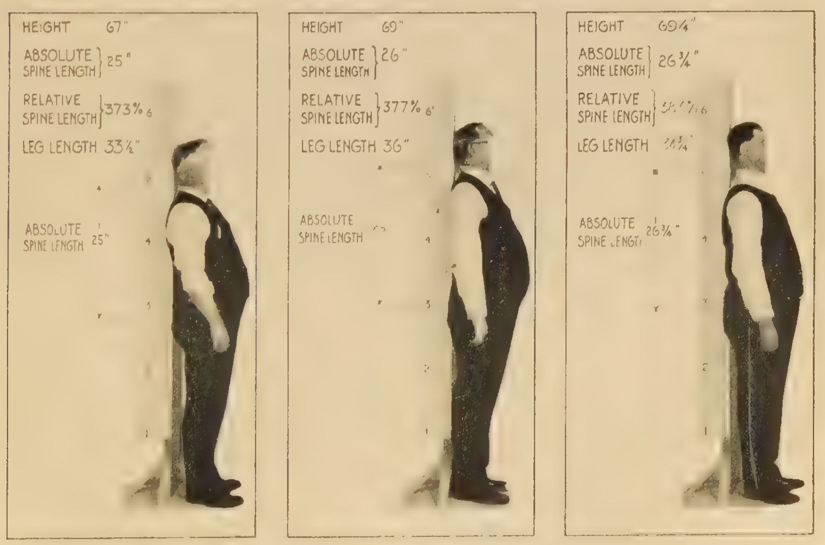
HEIGHT 67"
ABSOLUTE SPINE LENGTH 25"
RELATIVE SPINE LENGTH 37.3%
LEG LENGTH 33½"
ABSOLUTE SPINE LENGTH 25"
HEIGHT 69"
ABSOLUTE SPINE LENGTH 26"
RELATIVE SPINE LENGTH 37.7%
LEG LENGTH 36"
ABSOLUTE SPINE LENGTH
HEIGHT 69¼"
ABSOLUTE SPINE LENGTH 26¾"
RELATIVE SPINE LENGTH
LEG LENGTH 34¾"
ABSOLUTE SPINE LENGTH 26¾"
4
3
2
1

Plate B. Men of medium height, overweight on standard table, with increasing or relative spine-lengths.

TABLE 3

Comparison of actual and expected mortality among overweights, 1887–1908. By height class and relative spine length. White male issues of Union Central Life Insurance Company*

All build classes

BUILD CLASS AND RELATIVE SPINE LENGTH	ALL HEIGHT CLASSES			OVERWEIGHT SHORT MEN†			OVERWEIGHT MEN OF MEDIUM HEIGHT‡			OVERWEIGHT TALL MEN§		
	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected
All build classes‖	4,571	4,299.2	106.3	786	760.7	103.3	2,683	2,582.5	103.9	1,102	956.0	115.3
Relative spine length:												
Above limit of S.D. + from mean	493	468.2	105.3	117	108.4	107.9	286	271.0	105.5	90	88.8	101.4
Within limits of S.D. + or − from mean	3,573	3,334.3	107.2	596	575.7	103.5	2,107	1,998.2	105.4	870	760.4	114.4
Below limit of S.D. − from mean	505	496.7	101.7	73	76.6	95.3	290	313.3	92.6	142	106.8	113.0

* Select and ultimate, by M. A. Table.

† Short men 66 inches and under.

‡ Men of medium height, 67 to 70 inches.

§ Tall men, 71 inches and over. (Page 7, Vol. II, Medico-Actuarial Investigation).

‖ For build classification see pp. 120–121, Vol. I, Medico-Actuarial Investigation, also p. 173, *Proceedings* 34th Ann. Meeting, Association of Life Insurance Medical Directors, 1924.

TABLE 4

Comparison of actual and expected mortality among overweights, 1887–1908. By height class and relative spine length. White male issues of Union Central Life Insurance Company. Build Class I

BUILD CLASS AND RELATIVE SPINE LENGTH	ALL HEIGHT CLASSES			OVERWEIGHT SHORT MEN			OVERWEIGHT MEN OF MEDIUM HEIGHT			OVERWEIGHT TALL MEN		
	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected
Build Class I........................	2,786	2,840.9	98.1	467	484.4	96.4	1,687	1,741.5	96.9	632	615.0	102.8
Relative spine length:												
Above limit of S.D. + from mean....	251	265.8	94.4	58	61.7	94.0	150	155.5	96.5	43	48.6	88.5
Within limits of S.D. + or − from mean	2,198	2,224.0	98.8	361	369.1	97.8	1,334	1,360.1	98.1	503	494.8	101.7
Below limit of S.D. − from mean....	337	351.1	96.0	48	53.6	89.6	203	225.9	89.9	86	71.6	120.1

See Footnotes for table 3. These apply also to this table.

TABLE 5

Comparison of actual and expected mortality among overweights, 1887–1908. By height class and relative spine length. White male issues of Union Central Life Insurance Company. Build Class II

BUILD CLASS AND RELATIVE SPINE LENGTH	ALL HEIGHT CLASSES			OVERWEIGHT SHORT MEN			OVERWEIGHT MEN OF MEDIUM HEIGHT			OVERWEIGHT TALL MEN		
	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected
Build Class II........................	1,329	1,135.8	117.0	235	209.8	112.0	752	667.7	112.6	342	258.3	132.4
Relative spine length:												
Above limit of S.D. + from mean......	169	154.5	109.4	45	34.7	129.7	88	90.2	97.6	36	29.6	121.6
Within limits of S.D. + or − from mean.	1,029	864.2	119.1	169	156.6	107.9	596	505.8	117.8	264	201.8	130.8
Below limits of S.D. − from mean......	131	117.1	111.9	21	18.5	113.5	68	71.7	94.8	42	26.9	156.1

See Footnotes for table 3. These apply also to this table.

TABLE 6

Comparison of actual and expected mortality among overweights, 1887–1908. By height class and relative spine length. White male issues of Union Central Life Insurance Company

Build Class III

BUILD CLASS AND RELATIVE SPINE LENGTH	ALL HEIGHT CLASSES			OVERWEIGHT SHORT MEN			OVERWEIGHT MEN OF MEDIUM HEIGHT			OVERWEIGHT TALL MEN		
	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected	Actual deaths	Expected deaths	Ratio, actual to expected
Build Class III	398	**	**	72	**	**	208	150.4	138.3	118	**	**
Relative spine length:												
Above limit of S.D. + from mean	61	**	**	12	**	**	38	19.6	193.9	11	**	**
Within limits of S.D. + or − from mean	304	216.0	140.7	56	42.3	132.4	153	115.5	132.5	95	58.2	163.2
Below limits of S.D. − from mean	33	**	**	4	**	**	17	15.3	111.1	12	**	**

See Footnotes for table 3. These apply also to this table.

** Insufficient data.

second, with long spines, and the third, those with short spines. The material was then ready to tabulate for the actual mortality experienced as contrasted with the expected mortality according to the Medico-Actuarial Table, with due regard to the effect of medical selection during the first five years of insurance.

The resulting mortality tables are shown herewith.

The first of these is for all build-classes combined. The 38,062 overweight entrants who were classified in this table gave an aggregate of 400,331 years of life exposed to risk, or an average of 10.5 years. There were 4,571 actual deaths and 4,299 expected deaths according to the M. A. Table (Select and Ultimate), or a ratio of 106.3 per cent actual to expected mortality. The entire group gave a mortality similar to that of other groups of overweights carefully selected by insurance medical directors. A further examination of table 3 will show that short overweights and those of medium height have a lower mortality than those who are tall, the two former groups giving a ratio of 103.3 actual to expected and 103.9, respectively, as contrasted with a ratio actual to expected of 115.3 per cent for overweight tall men. This likewise is in accord with expectation. Tall men, as a group, especially at the younger ages, give higher mortality than the average. Those who are five feet, eleven inches or taller and under age 40 have a mortality in excess of the standard mortality tables even under the most favorable conditions of weight.

Our chief interest in this study, however, was to determine the mortality ratios according to spine length. In the entire group, that is, all build-classes combined, those with short spines, namely, those who are below the limit of the standard deviation from the mean, have the lowest mortality, 101.7 per cent of the M. A. Table. This condition is particularly striking for the overweight short men (95.3 per cent) and overweight men of medium height (92.6 per cent). Among tall overweights, on the other hand, those with long spines have a much better mortality (101.4 per cent) than those with short spines (133.0). It would appear, therefore, from this preliminary survey at least, that only among tall men was the suspicion of the medical directors confirmed as to the advantage of a long trunk. Among short men and among men of medium height, the very reverse condition prevailed.

A similar relationship is found in each one of the build-classes. Thus, Build-Class 1 (table 4), that is, those who are moderately overweight, and who constitute the bulk of this experience, showed a mortality of only 98.1 per cent ratio of actual to expected. The tall men in this group showed a somewhat higher mortality than the short men and the men of medium height but not materially so. But, the very lowest mortality is found among those with short spines among short men and men of medium height; whereas, among the tall men of this class, the best mortality was found among those with relatively long spines. In Build-Class 2 (table 5), a parallel situation was found, all of the figures being proportionately higher because of the increased mortality with added weight. Unfortunately, Build-Class 3 (table 6) was not large enough to give significant figures in each one of the sub-divisions. But, the figures that are available, show essentially the same conditions.

We may summarize the findings of this investigation to this point as follows: A fundamental difference between tall men, on the one hand, and short and medium height men, on the other, exists with relation to relative spine length and mortality. Among tall men, those who have above average relative spine lengths, that is, those who have short legs, have a very much better mortality than those who have below average relative spine length, that is, those who have long legs. Among short overweights and overweights of medium height, this particular relationship is reversed.

Possibly, these results indicate that relative spine length is not of itself a sufficient criterion of physical fitness among overweights. For this reason, we thought it would be desirable to bring into the picture the additional measurement of chest capacity to see whether this added factor would not clarify the results of the investigation of spine length and mortality.

Let us first examine the statistical constants of chest-girth in relation to height and relative spine length. These are a necessary preliminary to a classification of the materials for the mortality investigation on these items.

The first point of interest is that chest-girth increases with total height. Within a given height class, there is no important variation of chest-girth with an increase in relative spine-length. It is also observed that with increase in height there follows an increase in the variability of chest-girth, that is to say, short men adhere more closely to the average chest-girth than do tall men. Within each height class (i.e., overweight short men), there is no change in the variability or dispersion of chest-girths with increase in spine-length. These findings suggest therefore that the chest-girth factor does not account for the peculiar mortality showing of the relative spine-length classes reported above. As will be shown in the next table, chest-girth is an independent factor and within chest-girth classes the showing with respect to relative spine-length is approximately the same as for all chest-girth groups combined; the short men and men of medium height have the lower mortality ratios in the lower spine-length classes and tall men give the more favorable readings in the high relative spine-length group.

For the purpose of this study, we established two chest-girth classes: (1) Chest-girths below the mean; (2) chest-girths above the mean; and distinguished these two groups in each one of our previous classifications of relative spine-length. The mortality results of this classification are shown in table 8. Regardless of the classification by chest-girth, tall overweights still show lower mortalities in the long spine-length class, and short men and men of medium height show the lower mortality readings in the long spine-length classes, quite irrespective of whether the chest measure is below or above the mean.

The classing of the material by chest-girth brings out another surprising conclusion. Invariably, the lower mortality is show in the chest-girth groups *below* the mean. Combining the chest-girth and relative spine-length readings, we may say that the best mortalities are found among overweight short men and men of medium height with *short* relative spine-length and with chest-girths *below* average. For overweight tall men, the mortality is best among *long* relative spine groups and with chest-girths *below* average!

The above results indicate that we cannot depend upon the original Dreyer tables, neither for practical life insurance underwriting nor for general use in clinical medicine. The assumptions of Dreyer led

TABLE 7

Chest girth in relation to relative spine length among overweight men. Union Central Policy Issues, 1887 to 1908. Statistical constants for chest girth in each relative spine length class

OVERWEIGHTS: HEIGHTS AND RELATIVE SPINE LENGTH	STATISTICAL CONSTANT FOR CHEST GIRTH					NUMBER OF CHEST GIRTHS	
	Mean chest girth (M)	Standard deviation (S.D.)	Coefficient of variation $(V) = \frac{S.D. \times 100}{M}$	Skewness (S)	Excess (E)	Below mean	Above mean
	inches	*inches*					
All height classes combined:*							
Relative spine length (total)......	38.78 ±0.008	2.25 ±0.006	5.8	−0.179 ±0.004	0.075 ±0.002	19,798	18,259
Below mean R.S.L. (−S.D.)....	38.70 ±0.023	2.27 ±0.016	5.9	−0.124 ±0.012	0.084 ±0.006	2,535	2,157
About mean R.S.L. (±S.D.)....	38.78 ±0.009	2.23 ±0.006	5.8	−0.180 ±0.005	0.069 ±0.002	15,318	14,084
Above mean R.S.L. (+S.D.)....	38.87 ±0.025	2.37 ±0.018	6.1	−0.224 ±0.013	0.088 ±0.010	2,045	2,018
Overweight short men:*							
Relative spine length (total)......	37.37 ±0.016	1.95 ±0.012	5.2	−0.201 ±0.010	0.140 ±0.005	3,278	3,290
Below mean R.S.L. (−S.D.)....	37.21 ±0.052	2.03 ±0.037	5.5	−0.057 ±0.031	0.077 ±0.016	373	330
About mean R.S.L. (±S.D.)...	37.38 ±0.019	1.93 ±0.013	5.2	−0.211 ±0.012	0.152 ±0.006	2,415	2,488
About mean R.S.L. (+S.D.)...	37.44 ±0.044	2.04 ±0.031	5.4	−0.266 ±0.027	0.121 ±0.013	490	472
Overweight men of medium height:*							
Relative spine length (total)......	38.62 ±0.009	2.04 ±0.006	5.3	−0.173 ±0.005	0.091 ±0.003	12,691	10,193
Below mean R.S.L. (−S.D.)....	38.56 ±0.026	2.06 ±0.018	5.3	−0.201 ±0.015	0.085 ±0.008	1,641	1,254
About mean R.S.L. (±S.D.)....	38.60 ±0.010	2.03 ±0.007	5.3	−0.164 ±0.006	0.090 ±0.003	9,882	7,785
Above mean R.S.L. (+S.D.)....	38.87 ±0.029	2.10 ±0.021	5.4	−0.202 ±0.017	0.099 ±0.009	1,168	1,154
Overweight tall men:*							
Relative spine length (total)......	40.26 ±0.016	2.16 ±0.011	5.4	−0.174 ±0.009	0.100 ±0.004	4,629	3,976
Below mean R.S.L. (−S.D.)....	40.15 ±0.047	2.19 ±0.033	5.5	−0.045 ±0.026	0.280 ±0.013	553	441
About mean R.S.L. (±S.D.)....	40.24 ±0.017	2.13 ±0.012	5.3	−0.197 ±0.010	0.061 ±0.005	3,698	3,134
Above mean R.S.L. (+S.D.)....	40.64 ±0.057	2.34 ±0.040	5.8	−0.220 ±0.030	0.125 ±0.015	435	344

* Short men, 66 inches and under; men of medium height, 67 to 70 inches; tall men, 71 inches and over. (Page 7, Vol. II, Medico-Actuarial Investigation.)

Note: Figures following ± sign are "probable errors" of the respective constants. This figure signifies that it is an even chance that the true value of the constant lies within or without the limits set by the "probable error."

TABLE 8

Percentage, actual to expected mortality among overweight white males. By height, relative spine length, and chest measurement groups. (All build classes combined.) Union Central Policy Issues 1887 to 1908, experience carried to policy anniversary in 1921*

Select and ultimate basis by M. A. Table

RELATIVE SPINE LENGTH: CHEST GIRTH	ALL HEIGHT CLASSES			SHORT MEN*			MEDIUM HEIGHT MEN*			TALL MEN*		
	Actual deaths	Expected deaths	Ratio, actual to expected with P.E.†	Actual deaths	Expected deaths	Ratio, actual to expected with P.E.†	Actual deaths	Expected deaths	Ratio, actual to expected with P.E.†	Actual deaths	Expected deaths	Ratio, actual to expected with P.E.†
Totals	4,571	4,298.6	106.3±1.1	786	761.4	103.2± 2.5	2,683	2,579.3	104.0±1.3	1,102	957.9	115.0± 2.4
All spine lengths combined:												
Chest below mean	1,999	2,132.6	93.7±1.4	318	334.1	95.2± 3.6	1,232	1,326.5	92.9±1.8	449	472.0	95.1± 3.0
Chest above mean	2,572	2,166.0	118.7±1.6	468	427.3	109.5± 3.4	1,451	1,252.8	115.8±2.1	653	485.9	134.4± 3.5
Relative spine length:												
Below limit of S.D. (− from mean):												
Chest below mean	230	255.1	90.2±4.0	35	39.1	89.5±10.2	138	161.1	85.7±4.9	57	54.9	103.8± 9.3
Chest above mean	275	244.3	112.6±4.6	38	38.0	100.0±10.9	152	153.8	98.8±5.4	85	52.5	161.9±11.9
Within limits of S.D. (+ or − from mean):												
Chest below mean	1,564	1,662.6	94.1±1.6	230	244.5	94.1± 4.2	976	1,043.1	93.6±2.0	358	375.0	95.5± 3.4
Chest above mean	2,009	1,666.6	120.5±1.8	366	331.0	110.6± 3.9	1,131	949.8	119.1±2.4	512	385.8	132.7± 4.0
Above limit of S.D. (+ from mean):												
Chest below mean	205	214.9	95.4±4.5	53	50.5	105.0± 9.7	118	122.3	96.5±6.0	34	42.1	80.8± 9.3
Chest above mean	288	255.1	112.9±4.5	64	58.3	109.8± 9.2	168	149.2	112.6±5.9	56	47.6	117.6±10.6

* Height Groups were: *Short men*—66 inches and under; *medium height men*—67 to 70 inches; *tall men*—71 inches and over.

† P.E. = "probable error."

us to believe that the more favorable mortality ratios would be found among persons with relatively long spines and with chests above average. But, in general, the results of this investigation show a contrary indication, except in a minor way for tall overweights. It is possible, of course, that some of these results reflect medical selection. But, this can be at best only a minor item. There is still much in this study that calls for further examination, and it is hoped that additional investigations of the material will be made as time proceeds.

THE PRESENT STATUS OF OUR KNOWLEDGE OF THE ETIOLOGY OF PELLAGRA[1,2]

JOSEPH GOLDBERGER

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On March 26, 1735, nearly two hundred years ago, a physician, Doctor Gaspar Casal, practicing in the little town of Oviedo, Spain, made some notes on the first of a series of cases of a disease known to him and to the people of the locality as *Mal de la Rosa* (1). That disease we now know as pellagra.

Casal described the symptoms, termination and sequelae and discussed the cause, nature and geographic distribution of the disease; but it is Casal's ideas as to the cause which alone interest us at this time. He thought that the cause resided in a combination of atmospheric conditions and food; food rendering the body susceptible and the atmosphere through an inherent and "malignant" quality acting as the efficient or precipitating cause of the malady. The idea, thus for the first time expressed, that food was etiologically related to pellagra persisted but underwent in the course of time various modifications until the theory was evolved that pellagra is an intoxication resulting from the consumption of spoiled maize. With this theory of the etiology of pellagra the names of Sette (2), Balardini (2), Roussell (3), and more particularly that of Lombroso (4) are closely associated.

Needless to say, there had not been lacking among the older students some who believed that the disease was a communicable one. Such belief, however, had at no time been widely held and it had long been fairly completely dismissed from serious consideration in favor of what had become the authoritative and, in certain countries, the official spoiled-maize theory of Lombroso when Sambon (5), first in

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[1] Delamar Lecture delivered before the School of Hygiene, Johns Hopkins University, Baltimore, Md., March 1, 1926.

[2] Published with the permission of the Surgeon-General.

1905 and then more vigorously in 1910, attacked this theory and in its place advanced the view that pellagra was an insect-borne infection probably transmitted by some species of *Simulium* or buffalo gnat.

Thus upon the recognition of the disease as endemic in the United States, American students found these two conflicting views as the outstanding etiological theories and proceeded at once to subject them to critical examination with the result that both were soon rejected. In their place two other outstanding, likewise opposing, views developed: One, that the disease is an excreta-borne infection in which diet may play a more or less important but not an essential rôle; and the other, that the disease is primarily of dietary origin, a diet faulty or deficient in some, at that time, unknown respect being the essential factor in its causation.

The studies of the past ten or twelve years have tended, on the one hand, increasingly to invalidate the conception of pellagra as an infection and, on the other, to establish a more and more secure foundation for the theory of dietary deficiency. Indeed, it may be stated that our knowledge of the nature of the dietary deficiency has now become sufficiently clarified to warrant placing pellagra in a category closely related to, if not identical with, that of beriberi and scurvy. This, it is hoped, will be made clear in the discussion that follows.

It will be helpful to begin this discussion with a brief review of the more important reasons for considering pellagra as primarily of dietary origin.

The first of these reasons is the fact, as will presently appear, that the epidemiological and clinical evidence that has been advanced in support of an infective etiology either has not the significance that has been attributed to it or is equally consistent with the dietary view. Thus we find that the association of the disease with bad hygienic and sanitary conditions has been regarded by many as highly significant of an infection. But such association, it may be pointed out, is just about what might be expected of a disease of poverty and endemic pellagra, it may be recalled, is associated with the condition of poverty to an extraordinary degree (6). Furthermore, the reported studies that seemed to indicate a significant correlation between insanitary conditions, particularly as relates to methods of excreta disposal (7) (8) (9), do not bear critical analysis nor have they been supported by the results of more extensive studies carried out by later workers (10). If the association with poor sanitary conditions were really significant it would be reasonable to expect that the prevalence of the disease might be reduced or that the disease might even be eradicated by improving sanitary conditions. An experiment to test this was actually carried out by Siler, Garrison and MacNeal (11) in a cotton mill village of South Carolina and, as reported by them, with notable success in eradicating the disease. There is good reason to believe, however, that these workers fell into error in interpreting the result of the experiment, for the prevalence of the disease in the experimental village was later found by workers of the Public Health Service to be quite as high as in some other nearby villages with but the crudest methods of excreta disposal (12). It may be stated in this connection, that while there is no sound evidence that the disease can be prevented by improving sanitary conditions, other evidence of the failure of improved sanitary conditions to control the prevalence of the disease has been reported (13) (14).

Some of those who have regarded the association of the disease with poor sanitary conditions as significant, have reported evidence of the occurrence of contact with a preexisting case in a very high percentage of incident cases (7) (8) (9) (15) and have considered some of this as well nigh conclusive evidence of infection. It would be very instructive to examine this evidence in detail but it must suffice to state, as Vedder (17) and Goldberger and Wheeler (16) have pointed out, that much of it is consistent with the conception of a dietary deficiency and that which is not, is the result of faulty or inadequate methods of investigation and really without significance. That "contact" has not the significance that some observers have attributed to it is strongly indicated by its failure to operate under what would seem favorable conditions, as we shall endeavor to make clear presently in another connection.

The marked seasonal incidence of pellagra, its seemingly sudden appearance and alleged rapid extension in the United States with its notably higher prevalence in the Southern States represent epidemiological characters that one naturally associates with infectious diseases, so that it is not surprising that these have been cited in support of an infective etiology. In doing so, however, it was overlooked that such characters are not peculiar to infectious diseases. Excellent analogies may be found in the literature of beriberi (18) (19) so that they are, manifestly, equally consistent with a dietary etiology.

The notably higher incidence of the disease in adult women than in men has been cited in support of infection on the ground, presumably, that such difference is inconsistent with a dietary etiology. This is, however, by no means necessarily the case as witness, for example, the great preponderance of endemic goitre in girls as compared with boys of the same age (20). While it must be acknowledged that in the light of present knowledge the peculiarities not only of sex but also of age incidence exhibited by pellagra are not altogether satisfactorily explainable on a dietary basis, they are even less satisfactorily explained on the basis of infection. For to suggest a difference in "resistance," virtually the only explanation that the infectionist can advance, is an explanation that is manifestly equally consistent with the dietary theory and is itself in need of explanation.

Although a satisfactory explanation on a dietary basis of the phenomenon under consideration can not yet be formulated, a number of factors may, nevertheless, be suggested as possibly contributing to bring it about. Thus it is conceivable that during adult life there may be a quantitative difference between the sexes in physiological requirement of the special dietary factor related to pellagra, or there may be a difference in the length of the developmental period of the disease so that what, if not interfered with, would be the longer period of evolution of the disease in the male, may be conceived as cut short by seasonal changes in diet which do not come quite soon enough, however, to benefit the female in the same way. It may be suggested further that the housewife may, and on the basis of every day observation doubtless does in some instances, at least, favor the husband and other wage earning members of the household in matters of diet and, also, that the husband and other wage earning members may in some instances modify their diet advantageously by means of supplementary articles of food secured outside of the household. Finally, there may be mentioned as a possible contributing factor the fact of common observation that the diet of the woman (particularly of the housewife) is more likely to be affected by eccentricities than is that of the man.

Here it may be permissible to suggest that eccentricities in diet probably account for many of the sporadic cases both in the general population and in institutions, particularly institutions for the insane, just as they must account for similar cases of scurvy and of beriberi. This may also explain many, if not all, of the cases in well-to-do individuals although it may be well to point out that it by no means follows that all well-to-do individuals are always provided with a good diet, nor that even when so provided they always eat it. It should not be overlooked that well-to-do people may be food faddists, that they may be parsimonious, or be unfavorably situated with respect to sources of household food supply and, thus, that their diet may be one-sided, restricted and monotonous and possibly faulty in one or more respects (21). So that in studying the dietary relationship of the sporadic case, whether of one occurring in the home or in an institution, the student should not be content with ascertaining the character of the diet available, that is, of the general diet of the household or of the institution, but should strive to determine just what and how much it was that had in fact been eaten by the affected individual. Failure to do this, explains many, if not all, of the cases that have been reported as instances of the occurrence of the disease in spite of a good diet and, thus, as supporting an infective etiology (22).

The fact that the disease occurs in seemingly well-nourished individuals and in nursing infants has also been advanced as an objection to a dietary etiology. It is a sufficient answer to this objection to point to the same occurrence in scurvy and in beriberi.

In the light of the considerations presented it must be clear that the epidemiological and clinical evidence, on which the argument for infection has been based, either has not the significance that has been attributed to it, or is equally consistent with the dietary view.

The argument for infection has not however been based wholly on clinical and epidemiological grounds. A number of workers have advanced either bacteriological (2) or experimental evidence (23) (24) in its support. Of the reports belonging in this category there is only one of sufficient importance to be here considered. This is the report of Harris (24) of New Orleans of having infected two monkeys with pellagra by inoculating a filtrate from pellagrous tissues. Assuming that the diagnosis of pellagra in these animals was correct there is nothing in the report to show that it was not diet rather than infection that was the responsible factor. But it is by no means certain that the diagnosis was really correct. That it was an error has already been suggested by Funk (25) and is made highly probable, first, by the fact of the frequent occurrence in the monkey of eruptions that so far as may be judged are much like that described and pictured by Harris; second, by the important consideration that neither he (26) nor any other workers (27) have been able to confirm his original results and, third, by the still more important fact that a number of recorded attempts to transmit the disease to the human subject (28) by means of dermal scales, blood, nasopharyngeal secretions, urine and feces from cases of pellagra have been complete failures. The available experimental evidence must be regarded therefore as, on the whole, affording no support for the idea of pellagra as an infection.

It would seem then that, at best, the evidence so far considered either is equally consistent with the dietary hypothesis or actually affords the idea of infection in favor of which it was adduced no real support.

Let us now turn to some observations that, as will be seen, not only afford no support to, but are difficult or impossible to reconcile with an infective etiology. And, first of all, may be cited an observation reported by Külz (29), an army surgeon with the German army of occupation in Roumania during the World War. He has reported that in spite of the closest contact with the Roumanian population, among whom pellagra was prevalent, the several hundred thousand of the military personnel remained free from this disease although they were not exempt from attack by other endemic maladies, such as malaria, typhus, typhoid and dysentery. He characterized this, and, it would seem, not without warrant, as "evidence of very great weight in support of the argument against infection." In this connection, it is of interest to recall that the food conditions in Europe during the World War have been cited by some observers (30) (43) as well nigh conclusive evidence against the dietary origin of pellagra. These observers seem to argue that inasmuch as the people of Europe, particularly those of certain of the belligerent powers, were on starvation diets and necessarily badly nourished during the war, and since there was no pellagra amongst them, diet and malnutrition can have nothing to do with pellagra. So far as concerns the relation of a general malnutrition to pellagra this may be freely granted but it appears to have escaped those who reason in this way that if this argument were really valid as regards diet, it would also disprove the now well established dietary relationship of beriberi for, so far as is known, beriberi was no more prevalent than pellagra under the circumstances mentioned. The fallacy of the argument resides, of course, in the assumption that because a disease is the result of a faulty diet any faulty or inadequate diet will bring it about—a wholly unwarranted yet, curiously enough, a very common assumption. Evidently then the experience of Europe during the war is not inconsistent with the dietary hypothesis.

The experience of the German army of occupation in Roumania, to which reference has been made, in its failure to support the idea of infection is in close harmony with certain older observations the significance of which seems, however, to have escaped or has been misunderstood by the advocates of infection. These observations fall into one of two classes of which the first represents the experience of institutions, both special and general hospitals, receiving cases of pellagra for treatment. In such institutions physicians, nurses, attendants, etc., in frequent contact with the disease and directly or indirectly with the body discharges of persons sick with it, practically never develop the disease while so employed (31). A recent illustration of this is to be found in the experience of Enright (33) with pellagra in Egypt. He states that during the three years that he had dealt with some thousands of cases he was struck by the fact that all the orderlies, including British, Turks, and Germans, in attendance on the patients remained free from the disease. While we can not agree with Enright in considering this as proving that the disease is neither infectious nor contagious, his observation is certainly a very striking illustration of at least the failure of "contact" to operate when given what would seem to have been an excellent opportunity to do so.

Impressive as such observations are, those of the second class are very much more so. This class represents the experience of institutions to which cases of the disease may or may not be admitted but in which it is endemic or has, in some instances, been epidemic, or both. Thus, it has repeatedly been observed that employes (nurses, attendants, etc.) resident in such institutions, many of whom come in frequent association or intimate contact with active cases of the disease or their body discharges, or both, practically never contract the disease while so employed and so residing (31). This exemption, considering the circumstances, is extraordinarily difficult if not altogether impossible to reconcile with a hypothesis of infection. From the point of view of diet, however, an explanation readily suggests itself and, in fact, in the instances studied by us the exemption was consistently associated with what was believed to be a significant difference in diet. It would appear therefore that not only is the idea of infection without unequivocal support but there is important evidence with which it is difficult, if not impossible, to reconcile such idea but which is consistent with and is readily explained on a dietary basis. Clearly, then, the weight of the evidence so far reviewed, favors the dietary etiological view and more than warrants its adoption as a working hypothesis.

Now if this hypothesis is sound and pellagra is really due to a faulty diet, then certain implications which this hypothesis carries with it must also be true.

These are, first, that a difference in diet as between pellagrins and non-pellagrins be demonstrable; second, that the disease must be curable by a proper diet; third, that it must be preventable by such a diet, and, fourth, that it may be experimentally produced by diet.

The demonstration of a difference in diet as between individual pellagrins and non-pellagrins is frequently difficult or impossible particularly in localities in which the disease is endemic. The reason for this difficulty is, in the first place, the fact that we have no means for determining in a particular instance whether the seeming non-pellagrin is really free from the disease. Experience and analogy with other deficiency diseases both teach that in many instances the disease is very probably present but not developed to the point of symptoms. In the second place, our basic knowledge as to the nature of the dietary deficiency and, more particularly, as to the preventive value of different foods or combinations of foods is, as yet, much too meager to permit of reliable judgment in all instances as to the adequacy of a particular diet. This difficulty is enhanced, moreover, by the indefinite character of the information that is ordinarily available with respect to the diet of the individual. At best all that questioning can ordinarily elicit is a qualitative statement. In exceptional instances only can even a partial quantitative statement be secured. Manifestly therefore the determination of a difference in such circumstances is not to be expected. If, however, the comparison is not between individuals but between groups a significant difference is demonstrable or may reasonably be inferred to exist. Thus in a study by workers of the United States Public Health Service (34) carried out in some cotton mill villages of South Carolina in which the disease was endemic, comparison of diets of non-pellagrous with those of pellagrous households revealed that the pellagrous had a more restricted supply of such foods as milk and fresh meat. Similarly, in institutions in which the disease is endemic although the non-pellagrous class (consisting of officers and employes) may appear to and, perhaps, actually does receive exactly the same food as does the pellagrous (composed of the inmates) an indication of a difference in the diet of the two exists in this—that those of the unaffected class, being the officers and employes, are in a position both to serve themselves more liberally of the more desirable articles of the ration and to supplement the institution diet with articles of food or with meals secured outside.

Difficult as it may be to discern any difference in the individual diet in pellagrous households in an endemic locality, indications of a difference can very frequently be discovered in sporadic cases particularly in such as occur in well-to-do persons.

Examples of such cases may be found scattered in the literature. Particularly interesting are some of the cases reported by Vedder (17), Roberts (21), Eustis (35) and Wheeler (36), and a case in an army officer reported by Nichols (37). Nichols states that when his case was reported everyone said that this was an instance of pellagra in which the food factor could be ruled out, presumably, because there could be no question of the patient not having had a good diet available; but on going into the history of the case with the patient's sister he found that the patient "had always been a crank on diet, had never eaten meat, and always carried crackers around in his pockets."

If the dietary theory is sound and a difference in diet between pellagrin and non-pellagrin is demonstrable then, it has been suggested, a difference between the diet of a community or locality in which only exceptional, if any, cases occur and that of one in which the disease is highly prevalent should also be demonstrable. This is a reasonable expectation. Unfortunately, however, the attempt to demonstrate a difference in such circumstances calls for a laborious inquiry not only as to the diet directly but also as to the climatic, economic and other possible conditions that might affect the character of the food supply of a community or locality and thus, indirectly, of the character of the diet of its people. The observers who have reported that a significant difference is not demonstrable (7) (8) (9) (65) have reached this conclusion, we believe, because of inadequate and faulty methods of study of a difficult problem. The more soundly oriented inquiry carried out by Vedder (17) and that by the workers of the United States Public Health Service (6) resulted in adducing evidence that justified at least a strong presumption of the existence of a difference in household diet of contrasting communities. Thus, making due allowance for certain inherent difficulties, indications of a difference in diet as between pellagrin and non-pellagrin whether regarded as individuals, households or communities are frequently demonstrable or may reasonably be inferred.

In this connection the question naturally arises whether the marked annual fluctuations in pellagra prevalence, sometimes observed, can also be associated with fluctuations in diet. It has indeed been argued (67) that it is difficult to believe that the people of any considerable area should make such radical changes in their diet as would explain these fluctuations in prevalence. That this is a hasty and superficial view will at once be realized when it is recalled that quite similar fluctuations in prevalence are characteristic of such dietary diseases as scurvy, and beriberi, so that obviously considerable populations may make or, rather, may be obliged by circumstances to make "radical" changes in their diet. In reality, however, there is no need to assume that the changes in diet must be of a "radical" character. It seems to us quite possible that relatively slight and, superficially, perhaps quite inappreciable quantiative shifts may suffice to change what was perhaps a just sufficient diet into one more or less deficient in some one or more respects. Recalling the intimate relation that exists between economic conditions and pellagra incidence and recalling further that economic conditions are at times subject to violent fluctuations, one can readily perceive the nature of the force that may oblige the people of a household, of a community or even of a nation to modify their diet for worse or, it may be, for better. The depression in the price of cotton in 1914 consequent upon the outbreak of the war in Europe was followed by a great increase in pellagra in the cotton growing area of the United States in 1915. The recovery in the price of this staple during 1915 was followed by an equally or even more notable reduction of the disease in 1916. Can it be believed that the sharp restriction of credit that the planter or the merchant in the plantation area of the Southern States was obliged to impose on the plantation labor in the fall and winter of 1914 in consequence of his inability to sell his crop without loss was without effect on the diet of those people? No one acquainted with the agricultural economic organization obtaining in the plantation area will have any doubt of the answer.

There is much reason to believe, therefore, that the year to year fluctuations in pellagra prevalence are associated with fluctuations in diet and that these are reflections of fluctuations in economic conditions.

Passing now to the question of the place of diet in the treatment of pellagra, we find that opinion has varied considerably in the course of the long history of the disease but it is worthy of note that over half a century ago Roussel (3), on the basis of his own observations and the experience of others, assigned to diet the place of first importance.

The testimony of many careful observers and the results of recent studies all go to show that in uncomplicated cases of average severity the administration of a diet containing a generous allowance of milk and fresh meat is quite regularly followed by clinical improvement. With only rare exceptions, provided the patient coöperates fully in taking the diet, this improvement continues progressively to eventual complete clinical recovery without the use of any medication except such as may be needed to mitigate distressing symptoms or complications. Should the coöperation be unsatisfactory or the diet for any reason be inadequate, the attack takes a very different course: in the milder attacks the manifestations, particularly the eruption, may clear up and the attack may seem to subside. But such seeming improvement is temporary. After a variable period (possibly of weeks) the manifestations reappear, perhaps again to subside, but sooner or later these remissions cease. In other, as a rule more marked, cases no remissions occur, the attack with or without a period of seemingly stationary symptoms becoming progressively more pronounced and severe. Even at such more advanced stage a favorable change in food intake may be followed by improvement and recovery. It would seem clearly indicated therefore that diet operates as a dominating factor in controlling the clinical course and outcome of the attack. A conclusion that is strengthened by the fact that there are no observations however discordant they may have been thought to be that are really inconsistent with it (38).

That the specific treatment of pellagra resides in diet is further and more convincingly shown by the fact that the clinical recovery obtained by proper feeding is maintained as long as a proper diet is continued. In other words, recurrence of the disease so long dreaded by both laity and physician does not take place in those adequately nourished. This was for the first time demonstrated by studies carried out some ten years ago by Goldberger, Waring and Willets (39), and has since been confirmed by other workers (40) (41).

Not only was it demonstrated in those studies that the disease does not recur in those previously attacked but, still more, that it does not occur at all in those subsisting on an adequate diet. Since care was taken to make no changes in sanitary and hygienic conditions, nor as regards the character of new admissions to the institutions in which those studies were made, the complete prevention of both recurrent and new cases proved conclusively that pellagra may be prevented by diet without the aid of any other factor, hygienic or sanitary. And, it may be added, there is no good evidence that the disease can be prevented by any other means.

Not only has it been demonstrated that the disease is completely preventable by diet but, what is more, the production of the disease by diet has also been shown to be possible. In 1915, Goldberger and Wheeler (16) carried out an experiment at one of the Mississippi penitentiaries in which by feeding a diet resembling such as in previous observations they had found associated with a high incidence of the disease they succeeded in producing the disease in definitely recognizable form in at least six of eleven volunteers, all white male convicts. As controls they had the other residents of the penitentiary, 120 in all, of whom 47 were under observation throughout the experimental period. None of the controls developed any recognizable evidence of the disease.

This experiment has not escaped criticism. Shortly after the appearance of a preliminary report, MacNeal (42) (43) questioned its validity by casting doubts on the diagnosis of the experimental cases. MacNeal's criticism has recently been echoed by Merk (66) of Innsbruck. Referring to MacNeal's criticism, Wilson (44) of the School of Medicine of Cairo, Egypt, says: "MacNeal casts doubts on the correctness of the diagnosis; no one, however, with some experience of the disease can fail to be convinced, after reading Goldberger's recent paper, that these men suffered from pellagra; the writer from recent experience in Egypt would be inclined to believe, from the peculiar lingual and intestinal symptoms described, that four others might well have been included as pellagrous, leaving one only out of the eleven who does not appear to have become affected." If it be permissible to amend Professor Wilson's comment we would suggest that to be convinced that these men had pellagra, one other requirement must be fulfilled—namely, the possession of an open mind.

Although relatively great progress has in the past ten years been made in our knowledge of pellagra, this progress has been slow when compared with that recently recorded in connection with certain other diseases of nutrition. The difference is largely if not altogether due to the fact that for pellagra an experimental animal has been lacking. There is reason to believe, however, that this deficiency has now been supplied.

In August, 1917 Chittenden and Underhill (45) reported the experimental production in dogs, by feeding, of a pathological condition which they regarded as closely resembling human pellagra. Wheeler, Goldberger and Blackstock (46) have identified this experimental condition with the spontaneously occurring disease of dogs known to American veterinarians as black tongue. It is of interest to note that the resemblance of the spontaneous disease to human pellagra had been commented on by at least one observer (47) even before Chittenden and Underhill's publication. More recently Underhill and Mendel (48) have briefly reported some results of a study of this condition begun in 1918 and not yet completed. They state that the syndrome in the dog is associated with a lack of some unknown constituent of butter fat which is different from fat soluble A since cod liver oil does not protect. They have reached the conclusion also that fresh beef possesses some protective action, but in the absence of a sufficiency of the unknown effective agent present in butter the disease may be induced on a diet containing much meat but a longer period of time is necessary. The same statements are reported as applicable to casein which has been purified by boiling with alcohol. They have found also that egg yolk confers a certain degree of protection but is not as effective as butter fat. Carrots are reported as particularly effective in alleviating the syndrome when it is once initiated. In a paper that has just appeared Goldberger, Wheeler, Lillie and Rogers (49) report in a preliminary way, some results of a study of experimental black tongue that suggest very strongly that this condition and human pellagra are etiologically identical. They have induced this canine disease by feeding dogs certain diets previously found associated with the occurrence of pellagra, including the diet used in the human experiment carried out at a Mississippi penitentiary. Based on their experience with pellagra they have constructed a diet with which they are able regularly to induce this disease in the dog in from one to three or four months. They report that substances such as yeast, yeast extract and fresh lean beef, that were found to possess black tongue-preventive potency, have when tried in pellagra been found efficient preventives of the human disease and, conversely, that the substances such as butter fat, cod liver oil and casein that had failed in pellagra or that, like milk, were of low pellagra-preventive potency, when tried in black tongue failed or were feeble as preventives of the canine disease. In consequence of these striking findings they have adopted the working hypothesis that black tongue of dogs is the analogue of pellagra in man.

In the same publication these workers also report results that seem to indicate that the rat too will probably be found to serve as an experimental animal in the study of pellagra and of black tongue. We shall return to this presently in another connection.

Thus it would seem that we are warranted in concluding not only that indications of a difference in diet between pellagrin and non-pellagrin are demonstrable and that the disease is curable and completely preventable by a proper diet, but also that it may be experimentally produced by diet in man and with a high degree of probability (its analogue) in the dog, and possibly the rat, thus proving that the implications of the dietary hypothesis, so far as they have been tested, are true. Accordingly, in the light of the indications afforded by the evidence previously considered it may be concluded that diet is the primary controlling factor in the causation of the disease.

Accepting this conclusion the question now arises as to the nature of the essential dietary fault upon which the production of the disease depends. Needless to say, many suggestions along this line are to be found in the voluminous literature. The older of these, such as that of quantitative inadequacy, of monotony of diet, of monophagism, of spoilage or, specifically, of spoiled maize, and of carbo-hydrate excess have all been shown to be untenable. We may therefore pass on to a consideration of those more recently advanced. But even of these only the most immediately pertinent can for obvious reasons be considered.

We shall begin with the views advanced by Funk (50). In 1912 this worker provisionally included pellagra in a group of "deficiency diseases," all of which, he stated, could be prevented and cured by the addition to the diet of certain preventive substances called by him "vitamines."

Interesting and stimulating as this generalization has proved to be he advanced in its support, so far as pellagra is concerned, only certain epidemiological and clinical analogies to beriberi. More recently (51) he has expressed himself as inclined to the view—which he not altogether correctly credits to Goldberger—that the following factors are possible: "Partial lack of vitamines; lack of animal protein; lack of a still unknown vitamine; the combined influence of all these factors."

Inspired by Funk's and the other then recent developments in beriberi, Sandwith (52) in 1913 suggested that pellagra might be a "deficiency disease waiting for a vitamin to be discovered."

As the result of extensive studies, Voegtlin (53) in 1914 expressed the opinion that in the study of the etiology of pellagra serious consideration would have to be given to a deficiency or absence of certain vitamines in the diet, to the toxic effect of some substances, as aluminum, which occur in certain vegetable food and to a deficiency of the diet in certain amino acids. Later, from a study of the influence of vitamines on the clinical course of pellagra, Voegtlin (54) in association with Neil and Hunter reported that the administration of extracts from yeast and rice polishings which were highly efficient for the prevention of avian polyneuritis, in general failed to modify the course of the disease, but the administration to pellagrins of protein-free extracts obtained from liver and thymus gland, presumed to contain both the antineuritic substance and the fat soluble vitamine, "was followed by improvement in their condition apparently comparable to that produced by the consumption of a diet rich in fresh animal proteins." They concluded that "the dietary defect responsible for pellagra is distinctly (qualitatively) different from and perhaps more complex than the one causing fowl polyneuritis and human beriberi."

In 1918 McCollum, Simmonds and Parsons (55) on the basis of results of studies in rats, expressed the belief that pellagra is primarily associated with the unsatisfactory character of three dietary factors, namely, fat-soluble A, mineral elements and protein mixture. A year later, after having attempted to produce in rats a condition analogous to pellagra in man by feeding with diets similar to the diet employed by Goldberger and Wheeler in their experiment in convicts, and having observed in them only a "generalized poor condition," they (56) concluded that pellagra is caused by an infectious agent. More recently McCollum (57) has stated that "it seems established that pellagra is in some manner caused by faulty diet," but expresses no opinion as to the nature of the fault.

As the result of studies of diets of various groups, pellagrous and non-pellagrous, carried on in Egypt Wilson (44) reported in 1921 that the etiological factor is a deficiency of protein in the food best determined by an estimation of its biological value by means of Thomas' figures.

In 1920 Wood from some experiments with fowls, and by reason of seemingly favorable results of treatment with maize germ and wheat bran, reported that he was disposed to suspect that a vitamin-B deficiency is involved in pellagra but pointed out, at the same time, that there may be something else in the maize germ and the cortex of wheat that may account for the results observed.

Beginning their investigation of pellagra in 1914, Goldberger and associates have reported a series of studies the results of which they have interpreted as permitting the exclusion of one after the other of the known dietary essentials—until in 1922 they (58) concluded, on the assumption that all the dietary factors essential in human nutrition were known, that the essential etiological dietary factor is a specific defect in the amino-acid supply, probably in the nature of a deficiency of a special combination or combinations of amino acids. Realizing, however, that the assumption that all dietary essentials were known was of doubtful validity (59) but considering that as between the protein and an as yet unrecognized factor the probabilities favored the former as being the one concerned, they undertook a study of the therapeutic and preventive value of the protein of casein late in the summer of 1922. Early in 1925 they (60) reported that while the casein had had a beneficial effect on the general nutrition of their patients and in considerable measure prevented or, at least, notably delayed the development of the distinctive eruption, it did not prevent, though it may have delayed the relapse or recurrence of some of the other symptoms of the disease. They concluded therefore that the protein factor, if it be concerned in pellagra is not the sole preventive or causative factor and thus that some other heretofore unrecognized or unappreciated dietary complex also plays an essential rôle. This interpretation was supported by the results of a preventive study of dried skim milk when contrasted with those of a study of fresh buttermilk; on the basis of protein content dried skim milk proved itself distinctly inferior to fresh buttermilk. It was supported still more, perhaps, by the results of a study of the pellagra-preventive potency of dried yeast. In a daily dose of between 15 and 30 grams, representing less than 15 grams of protein, dried yeast was found very efficient in preventing the disease, a result that in view of the proved inadequacy of casein it was difficult or impossible to credit to its protein alone. They thought too that in view of the relatively small amount of protein furnished by the effective dose of yeast the special pellagra-preventive factor, which they designated as factor P-P, would seem capable of preventing the disease with little if any cooperation from the protein and, further, that it is possible that factor P-P plays the sole essential rôle in the prevention and causation of the disease.

This interpretation is strengthened by the results of further studies just reported by these workers (49). In tests of fresh lean beef and a commercial dried water extract of yeast they found both efficient pellagra-preventives. In this study the daily allowance of beef was 200 grams (7 ounces) and of the yeast extract 15 grams. In view of their previous experience with casein the protein of which in a daily allowance of 60 grams had been found not fully adequate entirely to prevent the disease, it is reasoned that since the allowance of beef yielded but about 45 grams of protein and that of the yeast extract could not have contributed over an equivalent of about 7.5 grams of protein, the potency of the beef and that of the yeast extract could not well be attributed to their protein alone. They therefore concluded that lean beef and yeast extract contain factor P-P and that this factor, in view of the effectiveness of the yeast extract with its small yield of protein, probably plays the primary rôle in the prevention and causation of pellagra.

They point out that the demonstration of the pellagra-preventive potency of yeast and yeast extract which, aside from protein and a negligible trace of vitamin A, has heretofore been believed to contain only the water soluble B vitamin naturally raises the question of the relation of factor P-P to vitamin B. They recall that although "water soluble B" has quite generally been considered as representing a single dietary factor with both antineuritic and growth-promoting properties (61), a number of investigators (62) have not accepted this view; inclining to the belief that it includes at least two distinct dietary essentials, namely, the antineuritic or beriberi vitamin to which alone, following Funk, the designation "vitamin B" belongs and a "growth-promoting" factor which some workers have attempted to identify with bios (63).

That vitamin B in the sense of the beriberi vitamin or antineuritic is not concerned in the etiology of pellagra or, in other words, that it is distinct from factor P-P and that these two factors may perform their physiological functions one independently of the other is, they state, even aside from any other evidence, quite conclusively shown by the rarity of association of beriberi and pellagra. The fact that these diseases in rare instances do occur together in the same patient in their judgment only emphasizes the significance of the rarity of such cases. Thus although the diet may be deficient in both the beriberi and pellagra-preventive essentials, ordinarily in relation to these diseases it is deficient in one and not, or clinically but inappreciably, in the other factor.

With respect to the relation of factor P-P to the so-called growth-promoting essential, heretofore possibly included in the term "water soluble B," Goldberger and associates bring forward evidence which seems strongly to point to their probable identity.

They state that having found yeast to contain the factor concerned in the prevention of black tongue and of pellagra, and having assumed, for reasons already referred to in a preceding connection, that this factor is the same for both conditions, they undertook a study of the characters of this factor as it exists in yeast. By means of black tongue-preventive tests in the dog they found that factor P-P is adsorbed from an acidulated water extract of yeast by English fullers' earth (Seidell's activated solid); that it is destroyed by charring the yeast but is damaged but little, if at all, when the yeast is heated in the steam autoclave at fifteen pounds pressure for 2½ hours. They report further that when young rats are fed a diet that is complete for growth except as to "water soluble B" and contains as the sole source of this vitamin as much as 30 or 40 per cent of such autoclaved yeast (Chart 1; Chart 2, period 4), their growth is quickly arrested, then their weight declines and they die with or without symptoms of polyneuritis, although the same yeast before autoclaving when forming 8 or 10 per cent of the diet furnishes sufficient "water soluble B" for good though not optimal growth. Thus, they point out, according to current ideas the autoclaving does not notably affect factor P-P but (in yeast) inactivates the "water soluble B." Evidently, too, factor P-P is not of itself growth-promoting in the rat. Furthermore, if the so-called growth-promoting water soluble vitamin of the yeast is distinct from both the antineuritic and the P-P factor, then clearly either the heating has inactivated it or like factor P-P it is not a special growth factor.

But that P-P or some associated, and in yeast relatively heat resisting, factor is essential for the growth of the rat is strongly indicated by the results of some work with autoclaved yeast recently reported from the Hygienic Laboratory by Smith (64) and clearly shown by Goldberger and associates by the following:

1. Young rats were fed a diet complete for growth except as to "water soluble B" and containing as the sole source of "water soluble B" as much as 30 or 40 per cent of autoclaved yeast which from tests in dogs had been shown to contain factor P-P; the rats quickly declined in weight, after a slight initial rise, and died with or without signs of polyneuritis, thus giving proof of an antineuritic deficiency (Chart 1; Chart 2, period 4).

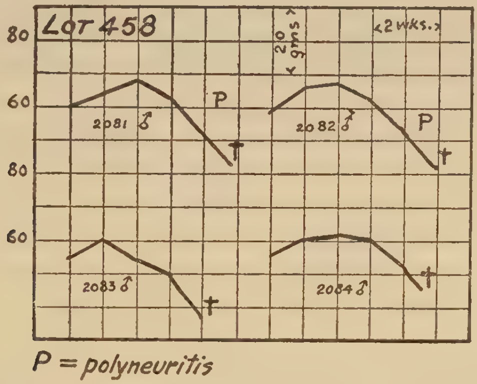

CHART 1. Weight curves of four young albino rats (Lot 458) whose diet (No. 227) included as the sole source of "water soluble B" 27 per cent of autoclaved yeast. Slight initial growth was followed by arrest and continued loss of weight terminating in death. Two of the animals developed signs of polyneuritis. (After Goldberger, Wheeler, Lillie and Rogers.)

2. Young rats were fed a diet complete for growth except as to the "water soluble B" but containing as the sole source of this vitamin as much as 40 per cent of a preparation of an alcoholic extract of corn meal (Chart 2, period 1) that was found potent in alleviating or curing polyneuritis in the rat. The animals notwithstanding an abundance of antineuritic quickly declined in weight after slight initial growth.

3. When, however, young rats were fed a diet as before complete for growth except as to "water soluble B" but containing as sources

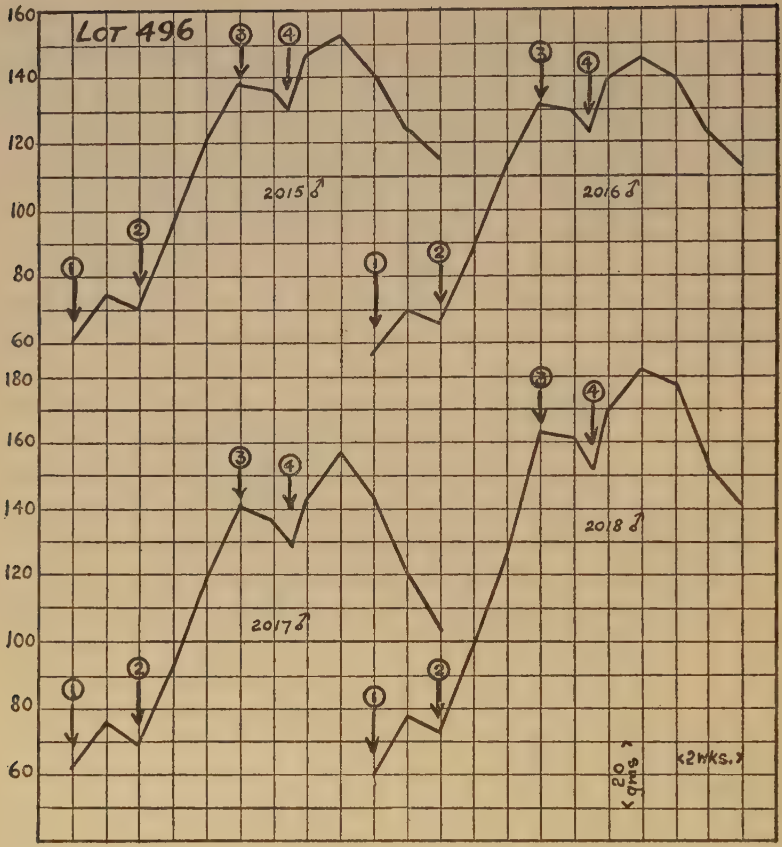

Chart 2. Weight curves of four young albino rats (Lot 496) during four dietary periods. During period 1 their diet (No. 218) included as the sole source of "water soluble B" 40 per cent of an alcoholic extract of corn. After an initial gain in weight they began to lose, whereupon there was added to their diet 9 per cent of yeast previously autoclaved at 15 pounds for 2½ hours. This was at once followed (period 2) with a resumption of growth which was well maintained during three weeks at the end of which a change in diet was again made. This change consisted of the withdrawal of corn extract and autoclaved yeast thus giving them the basic diet (No. 206) without any known source of "water soluble B." Growth was at once arrested followed by a downward trend in weight (period 3). Now another change in diet was made. The basic diet (No. 206) was replaced by one which included 40 per cent of autoclaved yeast as the sole source of "water soluble B" (diet No. 239). This change was followed by a resumption of growth which lasted but a short time and was followed by a progressive loss in weight. Thus neither 40 per cent of the corn extract nor 40 per cent of the autoclaved yeast when the sole source of "water soluble B" permitted the rats to grow but when only 9 per cent of the autoclaved yeast was added to the diet containing the corn extract growth took place and was maintained. (After Goldberger, Wheeler, Lillie and Rogers.)

of this vitamin as little as 8 or 10 per cent of the autoclaved yeast and as little as 5 per cent of the preparation of the extract of corn meal, the animals grew (Chart 3; Chart 2, period 2; Chart 4).

Again, when young rats were fed a diet complete for growth except as to the "water soluble B" and containing as the sole source of this vitamin 20 per cent of dried fresh lean beef which, judging by experience in both black tongue and pellagra, contains factor P-P, such animals after slight initial growth declined in weight and died with or without polyneuritis, thus indicating an antineuritic deficiency (Chart 5, period 1). When, however, on the appearance of signs of polyneuritis there was included in the diet of these animals as little as 5

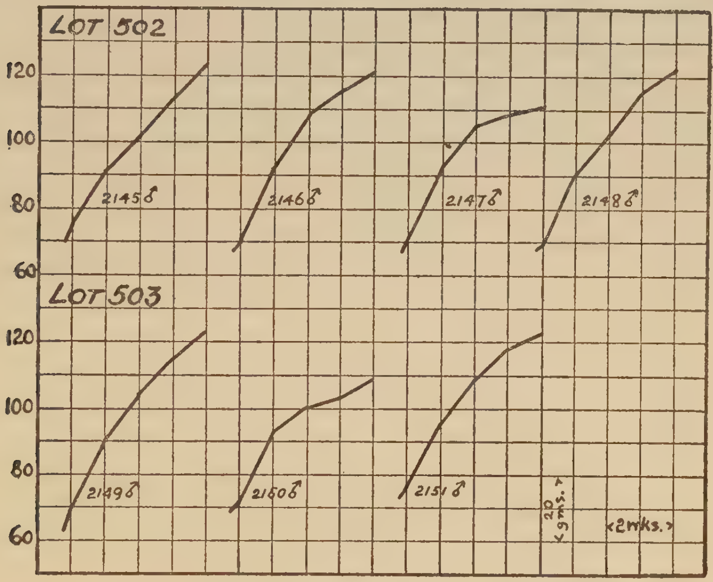

Chart 3. Weight curves of two lots of young albino rats. The diet of both was free of "water soluble B" except as supplied by 5 per cent of a corn extract combined with, in the case of lot 502, 8 per cent (diet 243E) and in the case of lot 503, 10 per cent (diet 243F) of autoclaved yeast. Although neither preparation alone when the sole source of "water soluble B" even to the extent of 40 per cent of the diet permits growth when, as here, much smaller proportions of each are combined growth takes place thus proving conclusively that this is not simply an additive phenomenon. The growth of these animals is at a somewhat reduced rate; for optimal growth the percentages of both corn extract and autoclaved yeast would have to be increased. (After Goldberger, Wheeler, Lillie and Rogers.)

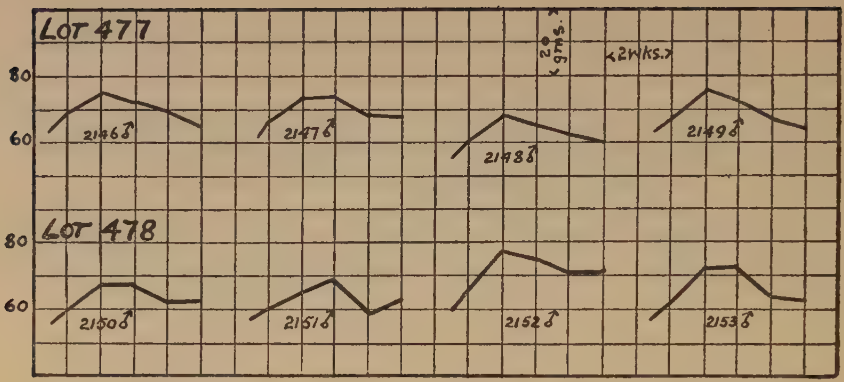

CHART 4. Weight curves of two lots of young albino rats. The diet of both was free of "water soluble B" except as supplied by 6 per cent (Lot 477, diet 238B) and 12 per cent (Lot 478, diet 238C) respectively of a corn extract. Growth was quickly arrested. (After Goldberger, Wheeler, Lillie and Rogers.)

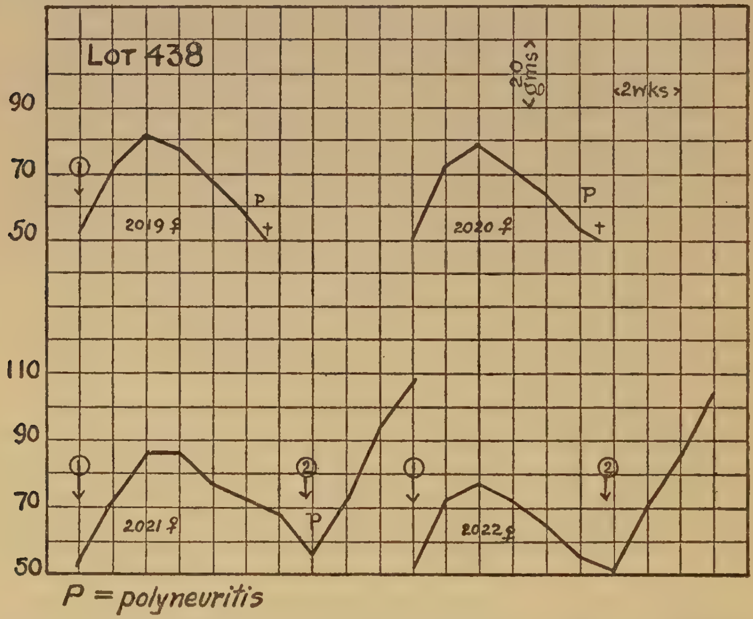

CHART 5. Growth curves of young albino rats (Lot 438) whose diet during period 1 included as the sole source of "water soluble B" 20 per cent of dried fresh beef. After some initial growth there was arrest followed by loss of weight with the development of signs of polyneuritis in three of the animals. After two of these died the diet was modified by adding 5 per cent of our corn extract (diet 219A). This was followed by disappearance of the signs of polyneuritis in the survivor showing these, with prompt resumption of growth in both survivors (period 2). The beef contained sufficient P-P but was deficient in antineuritic. The small addition of corn extract supplied enough of this to supplement P-P sufficiently to permit growth to take place. (After Goldberger, Wheeler, Lillie and Rogers.)

per cent of the preparation of alcoholic extract of corn, 40 per cent of which as the sole source of "water soluble B" in a diet does not enable the rat to grow, the animals that were not too far gone recovered from polyneuritis and resumed growth (Chart 5, period 2). Clearly the alcoholic extract of corn although capable of curing polyneuritis in the rat does not of itself promote growth but does permit or promotes growth when combined with a suitable proportion of a P-P containing substance, such as autoclaved yeast or beef, which itself, within certain limits at least, neither prevents polyneuritis nor permits growth.

Thus autoclaved yeast and beef muscle were shown to contain a factor distinct from the polyneuritis-preventing essential which, in combination with the antineuritic, is necessary for the growth of the rat. This factor which is perhaps identical with the yeast growth-stimulant or bios is at present indistinguishable from factor P-P; but whether the two are really the same, as seems very probable, will require further study to determine.

Summing up, it may be stated that the available evidence seems to leave no reasonable doubt but that pellagra is caused by a faulty diet. The primary dietary fault appears to be of the nature of a deficiency of a factor P-P, very probably but not certainly identical with a dietary essential, heretofore included with the antineuritic under the designation "vitamin B", which some workers have attempted to identify with bios.

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CONSTITUTION AND TYPE IN RELATION TO DISEASE

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From almost the beginning of medical history the rôle of constitution in relation to disease has been recognized, yet in spite of the age of this problem very little accurate scientific knowledge is available bearing on an exact connection between a definite constitution and the nature of its diseases.

Ultimately no doubt this problem must require much statistical and biometrical control but in its present phase considerable general morphological data are much needed. It is certainly equally as important to ascertain what to measure as it is to make the measurements. Undoubtedly much time and effort have been fruitlessly spent in making many careful measurements of meaningless characters. One is certainly highly optimistic who can survey the enormous accumulation of anthropometric figures and indices without feeling a considerable degree of disappointment over the almost complete absence of explanation or analysis of the causal elements in racial differentiation. The simple and very significant differences in cephalic index have scarcely given the slighest clue to the cause of head shapes or to racial relationships. The quite distinct anthropological differences between the two well recognized human types have indicated practically nothing as to their real nature or origin. Many anthropologists have considered head shape a most important racial feature yet if one should use such a criterion in classifying the various breeds of dogs he would become considerably confused. The dolichocephalic head of the Esquimo and the brachycephalic head of an achondroplastic man should cause some uncertainty regarding the use of head index as a racial criterion. This is not to be taken as a criticism of the anthropometric method in itself, but the way in which it has been employed has not proved very instructive.

During the past few years there has been a decided revival of interest in the study of the relation between constitution and predisposition to disease. However, in presenting the subject I have thought it best not to attempt a discussion of the specific problems on which we are at present engaged, and from which only very partial and somewhat indefinite results are available but, rather, to devote the present consideration to the general problem of constitution and the methods by which this problem may be definitely approached and possibly analyzed.

In the first place, before we are able to understand the relation of constitution and type to disease, it would seem necessary to know exactly what "type" and what "constitution" actually mean. As I consider the terms, type and constitution are not synonymous. The type indicates the fundamental character of the individual and remains fixed throughout life, while the constitution of the same individual changes during different life periods and may readily be greatly modified at any time. For example, a linear type individual may during adult life develop mild acromegalia—this does not alter the type though the constitution of the person becomes greatly modified. If pure types do exist, naturally type hybrids also occur. What are their characteristics and how are they to be recognized and classified? Probably a great deal of the uncertainty surrounding the connection between constitution and disease results from the fact that there is no clean cut agreement as to what the different constitutions actually represent. From the medical standpoint scarcely anyone has sought to determine the basis or origin of a definite type or constitution. There must be some uniform criteria for contrasting the several kinds of constitutions, and before this is clearly determined it is difficult to proceed. An accurate study of constitution itself seems to me the problem of first importance.

The general study of the whole subject has, however, largely proceeded the other way around. Physicians interested in disease have more or less intuitively come to believe that certain types of people do exist and seem predisposed to particular kinds of diseases. There is often a pronounced diathesis on the part of a given patient towards particular diseases. There is, for example, the tubercular tendency. Many discerning physicians are more or less successful in recognizing these tubercular disease types. But when the uninitiated seeks a definite description of the particular type it is most difficult, if not impossible, to obtain it except in vague, general and indefinite terms, and in almost no cases has serious study been devoted to the very important question of the nature, origin or development of the given type or to the very fundamental question,—whether an actual type is really concerned.

What is there peculiar about the composition or constitution of the particular patient which causes him to be subject to tubercular disease in contrast with the more resistant individual? Is this difference genetic or developmental in origin, or both, or is it due to differing degrees of an acquired reaction on the part of persons who have been subjected to some definite and peculiar environmental stress or condition? The answers to such questions as these are certainly necessary for a better understanding of the problem.

The physician studying constitution frequently confines his attention to only one life period of the individuals involved, and usually to the most static period, the adult. Dr. Draper in his recent anthropometric study of certain disease groups has confined his material to persons between the ages of eighteen and sixty. Such restriction eliminates almost all growing and developing individuals as well as many of the important late senility conditions. A study of such groups leads one to overlook arrested and childlike tendencies in particular persons as well as many abnormal secondary growth reactions. The rare occurrence of a typically adult disease among children may furnish a simpler clue to the constitutional diathesis than the study of great numbers of adults with this disease. Deviations and odd conditions often give the plan away more decidedly than routine happenings.

Constitution itself is not a static or fixed affair but is a developmental condition depending upon the genetic composition of the individual to a large extent, but also depending in a most important degree on the manner of development and growth. The constitution of a given individual is actually a different thing at different life periods. In this way constitution is to be differentiated from type which, as a rule, is characteristic and true for the individual throughout life—type is, as it were, the static element which underlies the changing constitution.

The prenatal period is probably the most important in determining all later constitutional conditions since at this time the actual gross body form and structure is being laid down and any environmental peculiarity may exert a marked influence on the course of development and may actually determine whether the individual will develop in a normal well-ordered fashion or into a deformed, crippled and deranged specimen. This prenatal stage, although probably the most important and the one on which all subsequent life stages directly depend, has been largely neglected and is almost unknown to the majority of physicians. A clearer understanding of the relation of constitution to type and to disease may be actually obtainable through a consideration of the embryonic and foetal development which has produced a given individual.

The constitution of babyhood is quite different from that of childhood. The undifferentiated and undeveloped baby reacts differently to the various types of food and other stimuli from the way in which the child does. The constitution of the child becomes considerably revolutionized at the time of puberty and the general reaction at this time is not entirely predetermined but may be modified by various environmental conditions; and youth, after puberty, passes through a stage of growth and maturity which largely depends on the success of the puberty changes themselves. Much is to be appreciated regarding the controlling elements in constitution by a study of these important changes. The final adult constitution is therefore a somewhat uncertain accomplishment which has been affected and influenced by both internal and external factors that have acted on the organism from the early stages of development until the final adult condition has been reached. Through all these various age periods of the constitution there exist distinct type differences which separate one group of age constitution from another.

Certain races tend to show characteristic constitutions which may differentiate them from other races in various ways, but aside from the general tendency of a well marked race to exhibit a more or less uniform racial constitution, there are individuals among all races which show widely divergent constitutions, differing entirely from the average pattern. Such individuals are either due to developmental deviations from the general pattern or to genetic modifications, and they are very important in analyzing the nature of the normal race pattern.

From the above, as indicating the general situation, it becomes evident I believe that we must determine whether different types actually do exist and what are their natures and general characteristics, since on these type differences constitution largely depends. A ready way to proceed may be to review in a general manner the information obtained from a study of lower forms. If types exist among the human population, it is quite probable that similar types also occur among other mammalian forms, particularly the domesticated animals.

We have been led to believe during the past few years that certain domestic mammals, such as dogs, exhibit in a pronounced way, a great many of the so-called types which have been recognized among men. In these lower forms many such types have actually been selected and preserved for centuries in some cases, and now constitute rather typical breeds or races of animals. The structural, physiological and psychological characteristics of a given breed are quite definitely maintained. By attempting to analyze these breeds through a comparison with certain experimental results, as well as with distorted developmental conditions, I believe we shall succeed in getting important information for a more logical understanding of the human conditions.

Before considering the types themselves we may briefly review the possible hereditary background of some exaggerated conditions in relation to certain disturbances and changes in the germ plasm. It has long been recognized that certain germ-cells in a normal parent may be weak and defective and it frequently happens among apparently good stock that peculiar genetic abnormalities arise. A very striking case in point has recently been presented by Sewell Wright from genetic studies on guinea pigs. A family of guinea pigs from ordinary stock began to produce a more or less definite abnormality affecting the development of the lower jaw and the position and development of the ears, a condition of otocephaly. The lines giving this peculiar condition were definitely recorded and all such animals could be traced back to a single brother-sister mating. The descendants from this mating, however, showed very different tendencies. Certain branches arising from the common ancestry failed entirely to show any abnormal development, while in other branches of the family a very high percentage of otocephalic individuals occurred in one generation after another. Dr. Wright found, on analysis, that this condition was transmitted as if multiple factors or a number of genetic units or genes were involved and the abnormality had probably arisen through some spontaneous modification in the genetic composition of the animals. The defect itself, however, is of the nature of a typical development arrest and without knowledge of the breeding records one would be inclined to interpret this situation as due to some developmental disturbance rather than to an heredity cause.

Modifications closely comparable to the above have been produced in experimentally treated animals. Certain chemical treatments when administered to guinea pigs and other animals seem to affect some of their germ-cells in a general way, causing these to give rise to poorly developed or actually abnormal individuals. The constitution and probably the type of these individuals are decidedly modified and differ from those of the general stock. An interesting result of this kind has recently been reported by Bagg and Little. Mice from well-known stock were subjected to short treatments by x-ray. The first few generations of descendants from these treated animals were quite normal but during later generations very peculiar abnormalities appeared and, by selection, it was possible to secure animals which produced offspring everyone of which showed underdeveloped and abnormal eyes. Among the same group of animals an abnormal kidney condition occurs, some individuals showing a complete absence of both kidneys while others may have abnormal kidneys or may have one normal kidney with the other entirely absent. A line of animals has been selected which breeds almost 100 per cent pure for kidney defects. Whether these peculiarities were actually induced by the x-ray treatment or not is at present impossible to say since the experiment has not been successfully repeated, but for our present consideration this is unimportant. The fact of real interest is that a peculiar genetic composition has arisen in this race of mice which causes them to produce peculiarly defective specimens. The constitution of such individuals is highly modified and they are certainly subject to definite structural diseases which are extremely rare among the stock population in general. A few other cases might be cited to show that the hereditary material itself may possibly become altered or modified so as to give origin to peculiar developmental processes which ultimately predispose the individual to very definite types of physical disease.

The nature of many of these defects which are definitely found to be germinal in origin is surprisingly similar to other defects which are induced by simply arresting the development of a typically normal embryo. In other words, the germinal modification seems to have caused simply a lowered developmental potential rather than to have altered any particular genetic character. When embryos are arrested at exact stages of development certain organs and parts are inhibited and modified in their structural development. It has been clearly demonstrated that these defects, which definitely modify type and constitution, are induced by disturbed development. The most convincing proof of this is shown by the frequent differences in developmental success attained by the two components of a double monster or twin individuals. It commonly happens among joined or united twin individuals that one component is arrested or handicapped in its development while the other develops perfectly normally. In this case there can be no doubt that the abnormality of one individual is solely due to some developmental disturbance since the genetic basis of both components must necessarily be identical. These examples of general modification resulting from disturbed embryonic development are of course quite monstrous and exaggerated in their condition, yet I believe that milder expressions of many such conditions as these are most important elements in the general determination and development of the different kinds of individuals among the normal population. Various human types, as well as the types among lower animals, should be clearly recognized as definite growth reactions which result from slight distortion in either the internal or external factors which affect development. Among extreme cases it is often easy to demonstrate this fact and also to show something as to what the cause has been. Since as a rule an almost complete series of gradations exists from these extreme cases, up to the really normal individual, we are finally justified in presuming that the slight deviations may be of the same general causal origin as are the more pronounced gross deformities.

We may now examine some of the more usually recognized and accepted types and shall again start with rather extreme forms. All physicians recognize several classes of dwarf persons. The best known and at present probably the best understood dwarf is the ordinary thyroid cretin. This individual in the typical case is largely infantile and almost completely arrested in a state of development comparable to early childhood. The condition is definitely known to be due to an extremely defective or absent thyroid gland, and is very characteristic and readily recognized in spite of the various racial groups or even animal species among which it occurs. It would seem to be a definite developmental affair. There is no genetic basis necessarily concerned yet it is not at all impossible that such conditions might arise from definite germinal causes.

Other types of dwarf, such as midgets and achondroplastics, are probably of somewhat more complex origin, and such dwarfs exist in typical form among dogs and among other of the lower animals. There is an hereditary background for their condition and such animals may be bred with a high degree of constancy, yet the expression of the condition is quite variable and rigid selection is constantly necessary to maintain a fixed quality of the stock. The King Charles Spaniel and the Pekingese breeds of dogs are midgets with considerable achondroplasia, and these also show rather marked exophthalmic conditions. The thyroid and other glands of internal secretion in these dogs show certain peculiarities in their histological structure and the function of the glands is considerably disturbed. The general modified structure and shape of the animal results very probably from these modified internal secretions, and yet the peculiar condition of the glands of internal secretion is very likely inherited in either a direct or secondary way. In other words, it seems at present that these dog breeds actually inherit a peculiar gland modification and, as a result of this modification, their entire growth pattern is distorted and modified. Their physiological and psychological performance is also peculiar, and quite characteristic of the definite individual type or breed. The breeds of dogs are known as groups to be either gentle or shy, kind, or irritable and snappy, stupid or intelligent, as the race may be. Persons having known one fox-terrier will know much about all fox-terriers but would find a very different character and behavior for a pointer, a bull-dog, or any other breed.

The French bull-dog and the British bull-dog show marked achondroplasia associated with different degrees of dwarfism. The causal factors here are quite similar to those just mentioned. These animal types exhibit very characteristic reactions which distinguish them more or less from the ordinary dog breeds, such as pointers and setters, in a great number of ways.

The point of particular interest to us is that the type peculiarities exhibited by these dogs are very closely comparable to the peculiarities found in human individuals of these same general types.

Among the dogs, gigantism is shown by the Great Dane, St. Bernard, Newfoundland, and others, and here, as in the human being, gigantism is very commonly associated with acromegalia. It would seem both in dogs and man that dwarfism and achondroplasia like gigantism and acromegalia are usual combinations. Here again among these giant dogs, such as the St. Bernard, one finds general characteristics and behavior closely suggesting that of the human acromegalic giant. The voice and disposition are actually strikingly similar.

A discussion of these extreme types might be carried still further, but it seems quite evident I believe from these few examples that the nature of the type or constitution in these cases is definitely associated with somewhat peculiar and modified growth conditions probably brought about in response to altered glandular reactions. The cause of this glandular alteration may have been primarily genetic. Here again one finds all gradations from these extreme glandular conditions back to the ordinary normal individual. If we examine more carefully the so-called normal individuals, good observers may frequently note slight indications of the conditions considered above. The structural expression of individuals oscillates between certain delicately balanced growth tendencies which are greatly influenced by the conditions under which the individual develops.

In studying both embryonic development and postnatal growth I have been led to believe that the rate at which growth or development occurs is a most important factor in determining the type and quality of the resulting structure. An individual that grows and differentiates rapidly, in the end shows a slightly different pattern from another which grows and differentiates more slowly. The rate of growth is no doubt dependent upon the rate of metabolism or rate of oxidation in the particular individual and, as far as our present knowledge goes, the one organ in the body having most to do in the long run with the rate of metabolism and growth is the thyroid gland. It may be that the slight differences in the activity of this gland have more or less to do with differentiating individuals into constitutional types.

When we study human beings as a group we find after careful inspection and on the basis of extensive anthropomorphic data that there tends to be in general two quite clearly contrasted types. The literature of anthropology indicates with surprising repetition that almost all anthropologists have originally recognized two human types. Roughly speaking, these are the long heads and the round heads. It is also true that when anthropologists have gone further with their studies they have become confused and have recognized in addition to the two original types a great number of other so-called types. When we look at the situation from a simple biological and developmental standpoint it seems easier to consider all the intermediate types as hybrids or mixtures of the two contrasted groups. A few years ago I attempted to point out the various contrasted characters in the two types and suggested that these simple differences in growth and development might result from slightly different metabolic rates in the two groups. This difference in rates of development was further associated with the thyroid activity of the individuals and this, in turn, might be decidedly influenced and affected by the nature of the environments in which the persons chanced to live for many generations. In general, it seems that all old and more or less sedentary races residing near the coast lines tend in type toward what is designated as the linear or high thyroid type, while the midcontinental people far removed from the sea and the source of iodine tended in the majority of cases to show a more rounded condition, a physiologically low thyroid or lateral type.

Since so many investigators in different fields have recognized these two types among human beings it seems strongly probable that such individuals actually exist and are typically differentiated from one another. The differences between the two types are not only shown in many measureable morphological characters, but are equally evident in their physiological reactions and certain psychological tendencies. These types have also been recognized by psychiatrists, who have designated certain distinct differences between them, as introverts and extroverts, schizophrens and cyclothyms and by numerous other terms.

The question of immediate connection and interest is whether, if these types do exist, they show different tendencies or diatheses towards the different diseases. Various clinicians from time to time have attempted to show that there are definite disease tendencies associated with certain type differences. Much of this work has been quite unsatisfactory, being very largely intuitive and impressionistic in nature. There is very little actually good quantitative data for consideration.

Recently, Dr. George Draper in New York has been conducting a study of various disease group individuals. He has not arranged the patients according to what might be considered type but has taken all individuals that actually showed a given disease and grouped these together. The measurements of the several groups have been compared. Many of his results seem to be important and are of considerable interest. The group comparisons often lend themselves, however, to further and different interpretations from those which Dr. Draper has pointed out. From this study of six different diseases, his curves and figures seem to indicate that only two of the disease groups are probably composed of a definite human type. The other groups are quite mixed in their characters and are probably composed of what one might term type crosses or hybrids. These disease groups differ from one another in more or less irregular ways and are not uniformly contrasted. It must always be recognized that a certain constitutional conditon may show the diathesis for a particular disease entirely aside from the actual type of the individual. Draper makes no attempt to check against this fact. We really have few facts to indicate that the constitution as such is evidenced in a definite way by particular physical measurements. A suprarenal depression, for example, may considerably modify constitution without altering physical measurements. Such conditions must be recognized by morphological appearance and the peculiar physiological reactions.

Draper's group that suffered from gall-bladder disease seems from the measurements to be composed largely of lateral type individuals, and the contrasted group exhibiting gastric or duodenal ulcer seems to be quite uniformly composed of linear type persons.

Members of these two disease groups are quite consistently contrasted with one another throughout the various measurements and indices which Dr. Draper has employed. Of course, it is not certain that all of his measurements or indices actually have any value or significance for type distinction since such a value for many of them has not been established. Certain physical proportions might readily be common to the two types just as hair and eye color are. It would not be expected, therefore, that these two groups should contrast in every way in which Draper has compared them, but certainly in many ways, and in all of those thought to be the most reliable qualities for type distinction they are definitely contrasted. Even to fine detail, such as toothpattern and hand and nail shapes, the ulcer group and the gall-bladder group exhibit the characteristics which have been pointed out by various investigators for the linear type and the lateral type respectively.

Sex of course is one of the most important factors in influencing both the constitution and the type of the individual, and very probably sex plays an important part in disease tendencies. Sex differences in the inheritance of haemophilia and other diseases indicates the importance in constitution of sex composition. As I have recently pointed out, the significance of sex constitution is also strikingly shown by the direction of the morphological changes which follow the removal of gonads in mammals and birds. Among the mammals where the female is believed to be homozygous for sex, having in her cells two X-chromosomes, and the male heterozygote having only one X, the castrated or spayed individual as the case may be approaches in its general structural trend the female or homozygous sex. While among the birds with the male instead of the female homozygous for sex, the castrated and spayed individuals approach in their structural changes the general male appearance instead of the female.

It is interesting to find that in Draper's ulcer group which is composed largely of the typical linear individual, the female is very rarely included. This disease would seem to be in the large majority confined to males. The linear type is rarely so fully developed or so well expressed by the female as by the male. In brother-sister groups, for example, the cephalic index is almost invariably higher among the females than among the males, and the female is more often rounded or lateral in her general structure than is the same class male. If gastric ulcer is a linear type disease then females might rarely show it as they are not usually of the pronounced linear type. On the other hand, it was found that in the gall-bladder disease group, the females predominated and the males of this group were rounded, fat, avirile individuals. Here again the round type is more fully expressed by the female than by the male in a mixed population. The general metabolism of the female is probably lower than for the male, as is indicated by her structural condition and reaction, although the difference may not be of such a magnitude as to be momentarily measured by the calorimeter.

The only other quite typical disease group shown by Draper's measurements was a small number of acromegalics. These of course are readily differentiated by ordinary morphologic criteria. The pernicious anemia group tended in their measurements very decidedly to approach the acromegalics. They had very large subcostal angles and had an average profile that tended toward the acromegalic picture. These anemic persons may by some possibility be a peculiar deviation from the bone growth state of the acromegalics. Both conditions may have some connection with calcium metabolism, and blood disturbance and bone disturbance in this way may be somehow interrelated.

It is most difficult at the present time to give any clear-cut or definite treatment of the relationship between human constitution and certain disease conditions. However, our present knowledge of inheritance and development along with a clearer understanding of the actions of the internal secretions in affecting body growth and form give present investigators a great advantage over earlier workers in understanding the relation of constitution to disease. The fundamental thing in this problem is in the first place clearly to determine the controlling elements in the development and differentiation of human constitutions. Until we actually understand the causes on account of which one constitution differs from another, it is most difficult to understand what their actual disease reactions mean. If there is any direct connection between the constitution or the type and certain disease inclinations it then becomes highly important to devise more clean-cut scientific methods for distinguishing type. Type cannot be designated intuitively with actual reliability and there must be established some quantitative basis on which it may be clearly diagnosed. We must determine which are the important characteristics and features to be measured, remembering that soft parts may frequently be as characteristic as bony structures though not so easy to study and hence their neglect at the present time by anthropologists in general.

The entire subject of constitution, therefore, is one urgently demanding study and investigation. An initial appreciation of extreme types and large deviations from the normal along with the way in which these function, and react to disease, will give a more scientific appreciation of minor deviations and the normal types themselves. Such knowledge will be of value in both preventive and curative medicine. This need not in any sense mean that persons able to distinguish types may further predict the kind of diseases that a given individual will some day develop. The hope is rather more in the direction that when type is clearly known we shall be better able to understand how a patient will react to a particular disease.

An appreciation and understanding of the patient is certainly one of the greatest advantages the physician can hold in his effort to control and alleviate disease. The most important element in the complex situation of disease is the actual human individual involved and all effort and study towards an understanding of this element will scarcely be energy misdirected.

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HELIOTHERAPY IN THE TREATMENT OF TUBERCULOSIS*

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While suncure is as old as humanity itself and has been empirically applied as far back as history records, it is only in the last twenty-two years that it has received any special attention, and not until very recent years has it been generally recognized by the medical profession. Even at the present time we have a few skeptics who are still unwilling to be convinced.

Dr. Rollier, who may be fittingly called the "Father of Heliotherapy," realized in his early career as assistant surgeon to Professor Kocher that so-called surgical tuberculosis was not an entity but only a local manifestation of a systemic disease and that operations were in these cases not only futile, but harmful, resulting in a majority of cases in an aggravation of the condition and the dissemination of the disease; oftentimes—in death. He therefore felt that the cure of so-called surgical tuberculosis was not a surgical but a medical problem and for a possible cure he must look to those agencies that would place the body organism in a state of defense. Even Hippocrates, centuries before the Christian era, proclaimed that "hunchback" was due to "tubercle within and without the body." We know that primitive man who lived out-of-doors and wore no clothes was immune to this disease of civilization but that as soon as he began to live in houses and to wear clothes, he then became especially susceptible.

With these thoughts in mind, Dr. Rollier in 1903 started on his venture of treating surgical tuberculosis in his clinics at Leysin, Switzerland, by placing his patients, naked, in an out-of-door environment, thus taking advantage of the natural agencies (sun and air) that are today recognized as possessing the greatest disease preventive, curative and health promoting qualities.

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His results, not only in tuberculosis but in other conditions where the resistance is low and the body needs to be built up, have been so pronounced as to be almost unbelievable unless one has had the good fortune of visiting Dr. Rollier's clinics or similar suncure centers either in Europe or in this country.

The Rollier method of solar irradiation was instituted at the J. N. Adam Memorial Hospital in the winter of 1913, after an extensive study by the late Dr. John H. Pryor of the methods used in the various clinics in Europe. For so long a period had surgical tuberculosis been relegated to the domain of surgery that our local physicians were loath to consider it in a new light. Add to this the fact that modern surgery had just reached the height of its triumph and was looked upon by many as the panacea for almost all human ills and you will agree that it required no small amount of courage to come out as an advocate of a treatment in which practically all surgical interference was discarded. But lack of courage was never one of Dr. Pryor's failings. He carried his point and the work was forthwith begun. At the start the technique of Dr. Rollier was adopted but during the intervening years we have spared no effort to improve on his methods by adapting them more satisfactorily to our peculiar climatic environment.

From a very small beginning in 1913 the work has grown in volume until we have under treatment at the present time 175 surgical and over 200 pulmonary cases. The new additions to our hospital have been so planned that we can extend the use of heliotherapy to practically all of our cases of pulmonary tuberculosis.

I wish to state at this point that, contrary to the opinion of most of those who are practising heliotherapy, and who advise against its use in pulmonary tuberculosis, I believe that if judiciously applied it is just as beneficial in this type of the disease as it is in the so-called surgical. A series of experiments that we carried out in the summers of 1922 and 1923 has convinced us of the justification of extending our sunlight treatment to include the pulmonary type. In fact, we have carried on suncure most satisfactorily in the favorable types of pulmonary tuberculosis since these experiments and we have employed it this summer for all of our pulmonary cases with the exception of those whose condition contraindicated its employment.

The unfavorable reactions reported by many of the observers on the pulmonary type of tuberculosis are not likely to occur provided proper precautions are taken and minute details in the technique are followed. Then, too, suitable cases must be selected. We naturally cannot expect any improvement in very active cases nor in those with acute complications or generalized tuberculosis.

In our work with joint tuberculosis we discard all casts so that the sun may have access to the whole body. This has led many to believe that immobilization is dispensed with. I cannot too strongly emphasize the fact that the Rollier method of heliotherapy is not mere insolation but a combination of sun insolation and rest in bed; and in a case of joint disease, the rest principle is further emphasized by position arranged with hard pillows or mechanical devices and tractions. This combination increases the resisting power of the patient and tends to preserve or restore the natural function of the joint, thus preventing or correcting deformity.

It is best that the patient, before he is started in the suncure, be gradually accustomed to the out-of-door life. The length of time required for this preliminary process depends, of course, upon the physical condition of the patient and on the season of the year. A robust patient, used to the out-of-door life, may be started at once during the warmer months—while the hectic, emaciated and bedridden one must be handled more cautiously. While moving air playing on the body is desirable during the summer months, it must be avoided during the cooler months of the year when a slight breeze striking the body may cause irreparable harm.

It is best that no sun bath be given for at least an hour before and two hours after a heavy meal. During the hot summer months it is advisable that radiation be given as early in the morning as possible since the heat of mid-day is very depressing and is likely to cause rise of temperature, nausea, rapid pulse, headache, and other constitutional disturbances. No doubt, some of the bad results reported following the use of heliotherapy may be attributed to this precaution not being taken. In Switzerland, Dr. Rollier begins his suncure during the summer months at 6 a.m. and gives the entire daily insolation dose in one period. This routine, while practical in Europe, is not feasible in this country with existing labor conditions. We therefore give our treatment in two periods, one and one-half hours in the morning and one and one-half hours in the late afternoon. In the colder seasons of the year we select the middle of the day for insolation when the temperature is more comfortable for the patient.

After each insolation the patient may be rubbed with spirits of camphor—and if the skin is very sensitive, some vegetable oil such as cocoanut or olive oil may be used.

It may be necessary to mention that, before treatment is instituted, a record should be made of the temperature, pulse and blood and urine findings. Cases with marked nephritis and those with fever and emaciation must be more closely watched and more gradually insolated. Every precaution must be exercised in order that cold breezes may not strike the body, since this, as mentioned above, may cause chilling and result in serious complications.

Rollier chooses to begin insolation with a five-minute exposure of the feet. This is not an arbitrary choice but one based on the idea that since this part of the body is most remote from the vital organs, its exposure is least likely to produce a shock. After this initial insolation of the feet, the rest of the body is exposed in the following order: the legs from ankle to knee, the thighs, the abdomen—and lastly, the chest. Open lesions are not uncovered to the sun until after all the rest of the body has been insolated. When the dressings are removed, they are replaced by a wire screen to keep off the flies and still allow free insolation of the part.

The following is our modification of Rollier's technique:

First day. The patient, reclining on a bed and dressed only in trunks and with head and eyes protected, is taken to the sun porch where neither glass nor screen comes between the patient and the sun. His body is covered with sheets or blankets down to the feet, which are exposed and insolated for periods of five minutes, three times during the day with intervals of about an hour.

Second day. Each insolation period of the feet is increased to ten minutes and during the last five minutes of each period the sheets are drawn back to the knees, thus giving the feet ten minutes and the legs from ankle to knee three five-minute exposures.

Third day. The feet are irradiated for fifteen minutes at each period. The insolation time of the part from ankles to knees is increased to ten minutes, and during the last five minutes the thighs are exposed and insolated.

Fourth day. Each of the three insolation periods is as follows: feet, twenty minutes; ankles to knees, fifteen minutes; thighs, ten minutes; abdomen, five minutes.

Fifth day. Each insolation period of each part previously irradiated is increased by five minutes, and the chest receives its initial exposure of five minutes each period.

This daily increase in the length of the irradiation periods is kept up until on the twelfth day the longest-exposed part receives a total of three hours, the exposure periods being—for the feet, sixty minutes; ankles to knees, fifty-five minutes; thighs, fifty minutes; abdomen, forty-five minutes; and chest, forty minutes. From this day on to the sixteenth, the insolation period of the feet remains sixty minutes, while that of the other parts keeps increasing at the same rate until the sixty-minute limit is reached by each one in turn. On the seventeenth day the change is made from three sixty-minute periods to two ninety-minute periods, one in the morning and another in the afternoon. If this length of insolation is contraindicated because of poor general condition, fever, very sensitive skin, etc., the time may be shortened. On the other hand, if the indications warrant, it may be increased to four hours by slow progression. The anterior and posterior surfaces should, if possible, receive the same amount of irradiation, the total exposure being divided equally between the two surfaces. In certain instances where the patient, either because of pain or general physical condition, cannot be turned to permit irradiation of the posterior surface, the anterior surface alone is insolated until improvement in the physical condition will permit the turning of the body —when the procedure outlined above is repeated.

While three hours of direct sun exposure for the average patient and four hours for the stronger and more robust ones has been found a sufficiently long period, these patients may be exposed to the air for practically any length of time with beneficial results. These air baths, in my opinion, are so important that I have encouraged our patients during the last six summers to go naked—not only during the three or four hours of sun treatment, but during as much of the day as possible. Throughout the summer months our children rarely dress but go to their meals and roam around the grounds and woods in their trunks. Since this has become the practise I have noticed a marked increase in improvement in all of our cases.

TABLE 1

Results of treatment of cases that were discharged from the J. N. Adam Memorial Hospital up to January 1, 1926, and who remained in the Institution three months or longer

DIAGNOSIS	TOTAL		APPARENT RECOVERY		ARRESTED		IMPROVED		UNIMPROVED		DEAD	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Tuberculosis of lymph nodes	468	45.3	381	81.4	48	10.2	28	6.0	6	1.3	5	1.0
Tuberculosis of peritoneum	107	10.4	82	76.6	14	13.1	3	2.8	8	7.5		
Tuberculosis of spine	81	7.8	30	37.1	23	28.4	11	13.6	13	16.0	4	4.9
Tuberculosis of hip	87	8.4	53	59.5	17	19.5	10	12.0	5	5.7	2	2.3
Tuberculosis of sacro-iliac joint	6	0.6	3	50.0	2	33.3					1	16.7
Tuberculosis of knee	47	4.5	26	55.3	12	25.5	4	8.5	3	6.3	2	4.3
Tuberculosis of ankle and foot	30	2.9	22	73.4	6	20.0	2	6.6				
Tuberculosis of wrist and hand	29	2.8	20	69.0	6	20.7	1	2.4	1	2.4	1	3.4
Tuberculosis of humerus	1	0.09			1	100.0						
Tuberculosis of femur	5	0.5	2	40.0	2	40.0	1	20.0				
Tuberculosis of ischium	1	0.09	1	100.0								
Tuberculosis of sternum	3	0.29	2	66.6	1	33.3						
Tuberculosis of kidneys	42	4.0	9	21.4	18	42.7	10	23.8	4	9.5	1	2.4
Tuberculosis of epididymis	13	1.2	6	46.1	5	38.4	2	15.5				
Tuberculosis of eyes	21	2.0	19	90.5	1	4.7			1	4.7		
Tuberculosis of jaw	1	0.09	1	100.0								
Tuberculosis of shoulder	9	0.87	2	22.2	6	66.6	1	11.1				
Tuberculosis of elbow	11	1.0	7	63.6	4	36.4						
Tuberculosis of sacrum	1	0.09	1	100.0								
Tuberculosis of phalanges	12	1.2	12	100.0								
Osteomyelitis (non-tuberculous)	33	3.2	15	45.5	9	27.2	9	27.2				
Lupus and tuberculous ulcers	5	0.5	4	80.0	1	20.0						
Empyema	15	1.5	7	46.6			6	40.0	1	6.7	1	6.7
Perthe's disease	1	0.09	1	100.0								
Rickets	5	0.5	5	100.0								
Total	1034	100	711	68.8	176	17.0	88	8.5	42	4.0	17	1.6

During the winter months it is obvious that exposure to the air must be very short, the duration depending upon the amount of tan and the physical condition of the patient. Up-cases with deep pigmentation may be exposed five to fifteen minutes at a time, with no ill effects. I have allowed our children to play in the snow for as long as an hour at a time.

In the course of the sun treatment the skin gradually takes on a bronze hue—then a copper color—and, finally, a beautiful chocolate brown. As pigmentation progresses, the skin becomes velvety and free from blemishes.

What surprises our visitors the most is the perfect physical development and firm musculature of patients who have been in bed even for years. While it is impossible to say whether it is the sun or the moving air that produces this muscle development, I am of the opinion that the moving air striking the body (which is a part of sun treatment) has considerable to do with it. Suncure is, after all, a combination of sun and moving air striking the body and in our enthusiasm we are likely to give too much credit to the sun and not enough to the moving air.

Dr. Rollier reports that the favorable progress of the cure is in direct proportion to the intensity of the pigmentation. While in general this is true, it must not be understood that no improvement takes place in cases that do not tan well, for we have had several instances where the tanning has been very poor but the improvement marked, and vice versa. Furthermore it is my belief that the relative intensity of the tanning must not be judged by its depth of color, but rather by how closely it approaches the ultimate pigmenting capability of the individual patient.

The negro is a good example. Without exposure to any light he is already well pigmented. Under sunlight his pigment deepens slightly, but noticeably, yet this slight change is as true an index to his response to light as the more noticeable change in the brunette or blonde.

The effect of solar irradiation on the general condition of the patients is most gratifying—to patient and physician alike. The haggard and spiritless appearance gives way to one of cheerfulness and animation; irritability and fretfulness disappear; the capricious

TABLE 2

Results of treatment of cases that were discharged from the J. N. Adam Memorial Hospital up to January 1, 1926, and who remained in the Institution three months or longer

DIAGNOSIS	TOTAL		APPARENTLY RECOVERED		ARRESTED		IMPROVED		UNIMPROVED		DEAD	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Tuberculosis of lymph nodes	468	45.3	381	81.4	48	10.2	28	6.0	6	1.3	5	1.1
Tuberculosis of peritoneum	107	10.4	82	76.6	14	13.1	3	2.8	8	7.5		
Tuberculosis of bone and joints	324	31.3	182	56.3	80	24.6	30	9.2	22	6.8	10	3.0
Tuberculosis of kidneys	42	4.0	9	21.4	18	42.7	10	23.8	4	9.5	1	2.4
Osteomyelitis (non-tuberculous)	33	3.2	15	45.5	9	27.2	9	27.2				
Tuberculosis of epididymis	13	1.2	6	46.1	5	38.4	2	15.5				
Tuberculosis of eyes	21	2.0	19	90.5	1	4.7			1	4.7		
Tuberculosis of skin	5	0.5	4	80.0	1	20.0						
Empyema	15	1.5	7	46.6	0		6	40.0	1	6.7	1	6.7

The above figures do not include 50 cases of pyo-pneumothorax and 115 cases of pleurisy with effusion, complicating either pulmonary or surgical tuberculosis that were treated with solar radiation. The results in these cases, especially where the pulmonary lesion was not severe, were most gratifying.

appetite returns to normal; there is a rapid alleviation of pain; temperature gradually comes down; weight and strength are taken on rapidly and the blood condition improves. Both the hemoglobin and red cells increase; leucocytosis, if present, becomes reduced and an actual lymphocytosis takes place. It is surprising how even the mental condition is improved.

The outstanding local result in the not too advanced cases of joint tuberculosis is the gradual restoration of function, partial or complete, in the affected joint. Whereas, in the ordinary expectant treatment with casts, or by operative procedure, the prognosis depends upon the completeness of the ankylosis, in heliotherapy, the aim is to restore the full function of the joint.

The action of the sun upon tuberculous tissue is one of repair. It appears to increase the rate of disintegration of cells damaged beyond repair while stimulating the activity of those which are undamaged. This is shown by an increase at first, in the amount of exudate from sinuses and ulcers accompanied frequently with swelling, edema and induration of the surrounding parts. This is followed by the subsidence of the swelling, the gradual diminution of exudate, the formation of healthy granulation tissue and a subsequent healing.

The action of the sun upon bone tissue is one of recalcification and spontaneous expulsion of sequestra.

The effect upon lymph nodes is one of gradual shrinkage with fibrosis, and in broken-down glands very often one of absorption or recalcification.

The effect on effusions is one of absorption. This is best noticed in peritonitis and pleurisy with effusion.

Abscesses may at first become larger, but are gradually absorbed or become calcified.

Sinuses at first react—as shown by profuse discharge and sloughing, but this is followed by the formation of healthy granulations and the gradual drying up and healing of the sinus.

Dr. Rollier, outside of aspiration, condemns any and all surgical interference. While the change from purely surgical measures to the ultra-conservative treatment prescribed by Rollier was a change in the right direction, I would not go so far as to say that surgery is never indicated. I have repeatedly observed that the removal of sequestra in osteomyelitis has hastened healing. The removal of the kidney is certainly advisable in unilateral cases when the disease is advanced.

I believe you will agree with me that operations to correct deformities that existed before or resulted in the course of treatment are advisable.

If operative procedure is resorted to, it is advisable that it should be preceded and followed by suncure. It is well also to bear in mind that there are many instances of extra-pulmonary tuberculosis which at first appear hopeless, whereas a few months of suncure change the whole aspect of the cases. I therefore always advise trying suncure before operation is attempted. If suncure fails, you have lost nothing. On the other hand, you have improved the physical condition of the patient so that operation is likely to be more successful.

We treat in bed all joint cases that are weight-bearing, using tractions, hard pillows and other mechanical devices to prevent or correct deformities. Cases of peritonitis, tuberculosis of the kidney, pleurisy with effusion, pneumothorax—whether they show fever or not, are also treated in bed until all symptoms and signs have subsided and sinuses and ulcers have healed.

Up to January 1, 1926, there have been discharged from the J. N. Adam Memorial Hospital, 1034 patients who presented some form of extra-pulmonary tuberculosis or other condition for which heliotherapy was applied and who remained in the institution three months or longer. Of the cases:

468 or 45.3 per cent were tuberculosis of the lymph nodes
107 or 10.4 per cent were tuberculosis of the peritoneum
324 or 31.3 per cent were tuberculosis of the bone and joints
33 or 3.2 per cent were osteomyelitis (non-tuberculous)
42 or 4.0 per cent were tuberculosis of the kidneys
13 or 1.2 per cent were tuberculosis of the epididymis
21 or 2.0 per cent were tuberculosis of the eyes
5 or 0.5 per cent were tuberculosis of the skin
15 or 1.5 per cent were empyema

Of the 468 cases of tuberculosis of the lymph nodes,

381 or 81.4 per cent were discharged as apparently recovered
48 or 10.2 per cent were discharged as arrested

28 or 6.0 per cent were discharged as improved
6 or 1.3 per cent were discharged as unimproved
5 or 1.1 per cent were discharged dead

Of the 107 cases of tuberculosis of peritoneum,

82 or 76.6 per cent were discharged as apparently recovered
14 or 13.1 per cent were discharged as arrested
3 or 2.8 per cent were discharged as improved
8 or 7.5 per cent were discharged as unimproved

Of the 324 cases of tuberculosis of the bone and joints,

182 or 56.3 per cent were discharged as apparently recovered
80 or 24.6 per cent were discharged as arrested
30 or 9.2 per cent were discharged as improved
22 or 6.8 per cent were discharged as unimproved
10 or 3.0 per cent were discharged as improved

Of the 42 cases of tuberculosis of the kidneys,

9 or 21.4 per cent were discharged as apparently recovered
18 or 42.7 per cent were discharged as arrested
10 or 23.8 per cent were discharged as improved
4 or 9.5 per cent were discharged as unimproved
1 or 2.4 per cent was discharged dead

Of the 33 cases of osteomyelitis (non-tuberculous),

15 or 45.5 per cent were discharged as apparently recovered
9 or 27.2 per cent were discharged as arrested
9 or 27.2 per cent were discharged as improved

Of the 13 cases of tuberculosis of epididymis,

6 or 46.1 per cent were discharged as apparently recovered
5 or 38.4 per cent were discharged as arrested
2 or 15.5 per cent were discharged as improved

Of the 21 cases of tuberculosis of eyes,

19 or 90.5 per cent were discharged as apparently recovered
1 or 4.7 per cent was discharged as arrested
1 or 4.7 per cent was discharged as improved

Of the 5 cases of tuberculosis of the skin,

4 or 80.0 per cent were discharged as apparently recovered
1 or 20.0 per cent was discharged as arrested

Of the 15 cases of empyema,

7 or 46.6 per cent	were	discharged as apparently recovered
6 or 40.0 per cent	were	discharged as improved
1 or 6.7 per cent	was	discharged as unimproved
1 or 6.7 per cent	was	discharged dead

The above figures do not include 50 cases of pyo-pneumothorax and 115 cases of pleurisy with effusion complicating either pulmonary or surgical tuberculosis, that were treated with solar radiation. The results in these cases, especially where the pulmonary lesion was not severe, were most gratifying.

Of the number that died, the cause of death of three was influenza during the epidemic, while in one case a psoas abscess ruptured into the intestines causing death in a few days. The remainder were cases of several years' standing with advanced pulmonary tuberculosis.

Fourteen per cent of the adults and 21 per cent of the children discharged had multiple lesions.

Fifty per cent of the adults and 27 per cent of the children had had surgical interference.

Seventy-six per cent of all the joint cases were discharged with partial or full motion.

Sixty-nine per cent of the adults and 16 per cent of the children had a diagnosable pulmonary lesion.

The average duration of illness before admission was about two and one-half years.

No case that has been confined to bed is discharged as apparently recovered until he has been up and about for at least six months, if the lesion is in the bone or joint, or three months in cases of other lesions. As a rule no bone or joint case becomes ambulant until x-ray examination shows good repair, all signs and symptoms have disappeared, sinuses and ulcers are healed and abscesses have been absorbed or calcified. The patient being in this favorable condition and feeling correspondingly well, the three to six months' probation period taxes his patience to the uttermost, and in all too many cases, he is induced by his restlessness to leave the institution before the proper time, with the result that our percentage of apparent recoveries is appreciably reduced.

Because of the uncertainty of the sun during the winter months and changeable seasons of the year, many attempts are being made by various manufacturers, whose interest in the matter is purely commercial, to put on the market lamps which by their names are suggestive of being substitutes for natural sunlight, mountain light, etc. While the necessity for some artificial sunlight substitute cannot be denied, we must not take the suggestive names for these lights seriously. There is not a lamp on the market today that closely approaches natural sunlight, either in intensity or spectral distribution. Even if we get a light that will come up to expectations, unless outside air conditions are imitated the results will never compare with those obtained by natural sunlight.

Heliotherapy must not be understood to be the application of light only, but the application of sunlight and fresh moving air to the body. Artificial light therapy is usually given in a closed room where the air is likely to be vitiated, and, therefore, while the results might be very good, they will not compare with those obtained in the open with natural sunlight.

We have three types of lamps on the market today—the carbon arc, the mercury arc and the incandescent.

The carbon arc is rich in short ultra-violet and in infra-red rays. The flame type of the carbon arc is richer than the plain type in visible light—especially the blue, but it contaminates the air with a smoke of metallic oxide.

The mercury arc is rich in the short wavelengths of ultra-violet but very poor in the visible and infra-red. It is rather poor in ultra-violet rays present in the sun but rich in the shorter wavelengths.

The incandescent lamp is very rich in infra-red rays but poor in the visible part of the spectrum (about 2 per cent) and still poorer in the ultra-violet (less than 1 per cent). It has very little of the pigmenting properties.

There has been considerable discussion of late as to the part played by the different portions of the spectrum. Clinical observations do not justify the assumption that the ultra-violet portion of the spectrum plays the principle rôle in the treatment of tuberculosis. While it is true that it is the pigment-producing portion of the spectrum—

still, it does not follow that it is the only effective part. The tan produced by ultra-violet radiation alone is certainly not equal to that of the sun, nor does the skin have the healthy, velvety feel which sunlight produces. The patient does now show the definite improvement of musculature and subcutaneous tissue. Therefore, until the matter is investigated further, we must take for granted that each portion of the spectrum plays its important part and that fresh, moving air, which is part of heliotherapy, plays also a most important rôle, heretofore not recognized nor given credit.

In more recent years solar radiation has been attaining wide recognition in the treatment of anemia, puerperal sepsis, osteomyelitis, neuritis, and in the convalescence from all wasting and infectious diseases. It is a specific in rickets. The treatment of these other diseases by heliotherapy is mentioned in the hope that such a unanimity of opinion will be created between the medical profession and the laity as will demand that there be established in connection with every general hospital, a center in a suburban district at which patients may share in the healing qualities of the sun and the invigorating influence of fresh air.

Let me also call your attention to the fact that the sun's rays are even more powerful in their prophylactic energies than in their therapeutic properties, and hence the advisability of the use of solar energy as a preventive of disease and a promoter of health. Let us insist upon more open-air schools and upon more out-door recreation—both for the young and old. If the propaganda for the widest possible utilization of fresh air and sunlight were promoted with one-half the vigor it deserves, we should soon see the dawn of a new day in which the forces of disease with its accompanying misery would be driven to their last defenses.

CONCLUSIONS

In conclusion, I wish to emphasize the following points:

1. That our present knowledge of the etiology, portal of entry and dissemination of tuberculosis justifies the opinion that so-called surgical tuberculosis is only a localized manifestation of a systemic disease, the primary focus of which is in other parts of the body,

and that we must therefore treat the disease as a whole and not its local manifestations only.

2. That any radical measures that tend to lower the resistance of the patient and aggravate or reactivate the disease, or that will deprive the patient of those forces that tend to build up his body resistance, should be looked upon with disfavor.

3. That operative procedure does not remove the cause but tends to aggravate or reactivate the primary focus; also, by attempting to remove the localized disease area, tends to break down the wall of granulation and connective tissue which nature so kindly provides as a protection to the surrounding structure, thus opening up new areas to infection and increasing the possibility of a generalized tuberculosis.

4. That operative procedure favors ankylosis and thus destroys the functions of a joint, while heliotherapy favors the preservation or re-establishment of function in a joint.

5. That operative procedure is justified only,—(*a*) in those cases in which, in spite of heliotherapy and the resulting good general physical condition, the local lesion has not shown any satisfactory improvement. (*b*) To correct deformities developed during the course of treatment in spite of all the efforts to prevent them. (*c*) To provide stability by an arthrodesis in a flail and useless articulation. (*d*) To evacuate abscesses, and this only by aspiration or a small incision when the pus is very thick. (*e*) In unilateral renal tuberculosis with marked destruction.

6. That solar radiation is a great muscle developer, as seen in the perfect musculature of those cases who have been in bed for years, and hence a very important factor in maintaining good positions and in preventing the development of deformity when the patient is up and about and convalescing. The long-continued use of casts for immobilization leads to the abolition of function through atrophic degeneration of specialized structures.

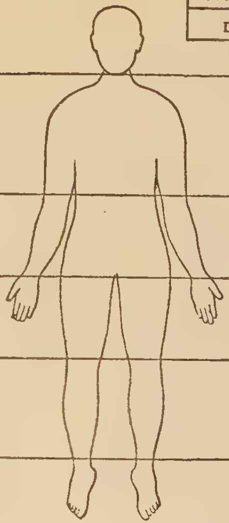
7. That during the summer, the irradiation period should be begun as early in the morning as the problems of hospital management will allow, and if not completed at this time, it should be continued as late in the afternoon as the sun will permit, so as to avoid the most intense heat and thus reduce the possibility of complications; and that in cold seasons, the sun exposure should be given at the middle of

the day when the temperature of the air most nearly approaches the point of comfort, the utmost care being exercised to prevent cold breezes striking the body.

8. That the results obtained with artificial light therapy do not by any means equal those obtained with heliotherapy,—first, because no artificial light, as developed by lamps on the market today, approaches natural sunlight either in intensity or in spectral distribution; and secondly, because with the conditions under which artificial light therapy is applied, the patient is deprived not only of the hygienic benefits of pure air, but of the effect of fresh moving air on the body, which forms an integral part of the sunbath, and which we surmise is the effective agent in developing musculature.

J N. ADAM MEMORIAL HOSPITAL

Name



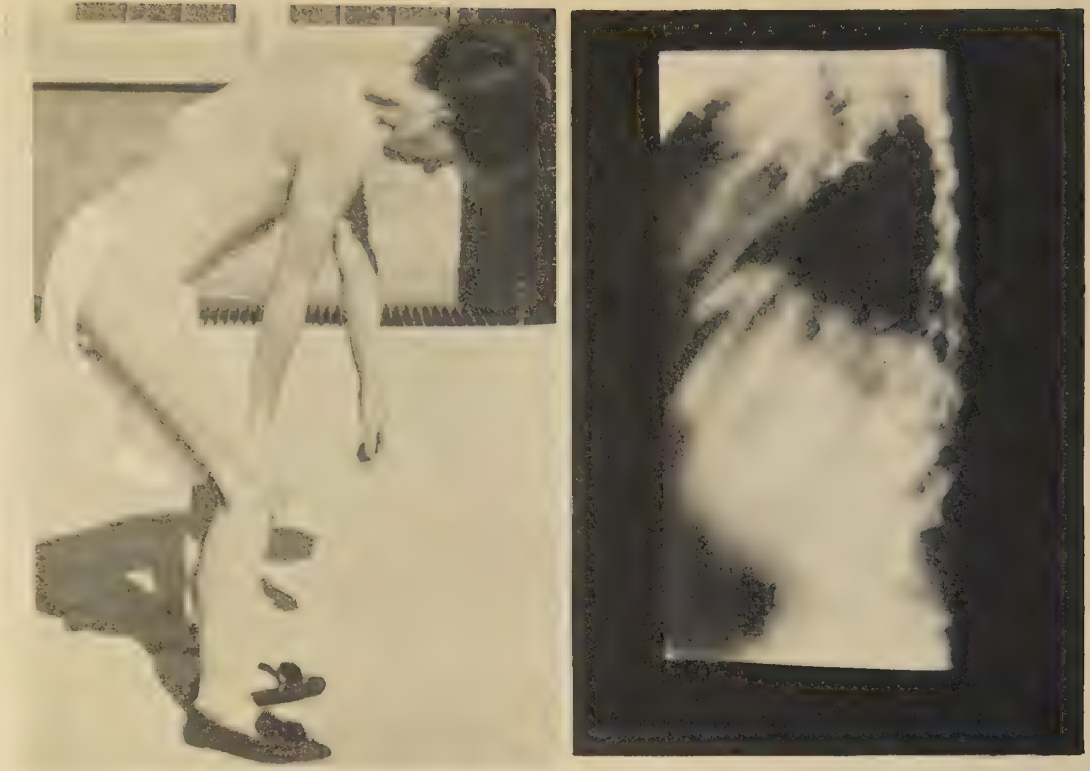
Date																	
Days		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th
		T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	T.I.D	B.I.D.
						5 Min.	10 Min.	15 Min.	20 Min.	25 Min.	30 Min.	35 Min.	40 Min.	45 Min.	50 Min.	55 Min.	60 Min.	The amount of exposure, from this day on, is the same except that the periods are divided into a morning and an afternoon period of 90 min. each.
					5 Min.	10 Min.	15 Min.	20 Min.	25 Min.	30 Min.	35 Min.	40 Min.	45 Min.	50 Min.	55 Min.	60 Min.	60 Min.	
				5 Min.	10 Min.	15 Min.	20 Min.	25 Min.	30 Min.	35 Min.	40 Min.	45 Min.	50 Min.	55 Min.	60 Min.	60 Min.	60 Min.	
			5 Min.	10 Min.	15 Min.	20 Min.	25 Min.	30 Min.	35 Min.	40 Min.	45 Min.	50 Min.	55 Min.	60 Min.	60 Min.	60 Min.	60 Min.	
		5 Min.	10 Min.	15 Min.	20 Min.	25 Min.	30 Min.	35 Min.	40 Min.	45 Min.	50 Min.	55 Min.	60 Min.	60 Min.	60 Min.	60 Min.	60 Min.	
Total Daily Exposure of part exposed longest		15 Min.	30 Min.	45 Min.	60 Min.	75 Min.	90 Min.	105 Min.	120 Min.	135 Min.	150 Min.	165 Min.	180 Min.	180 Min.	180 Min.	180 Min.	180 Min.	
THESE EXPOSURES ARE TO BE DIVIDED EQUALLY FOR ANTERIOR AND POSTERIOR SURFACES WHENEVER POSSIBLE																		
Time for the above Exposures	A.M.	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:45	8:15
	A.M.	9:50	9:55	10:00	10:05	10:10	10:15	10:20	10:25	10:30	10:35	10:40	10:45	10:45	10:45	10:45	10:45	
	P.M.	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15	3:15

No.

MODIFICATION OF ROLLIER'S SCHEMATIC DIAGRAM OF INSOLATION

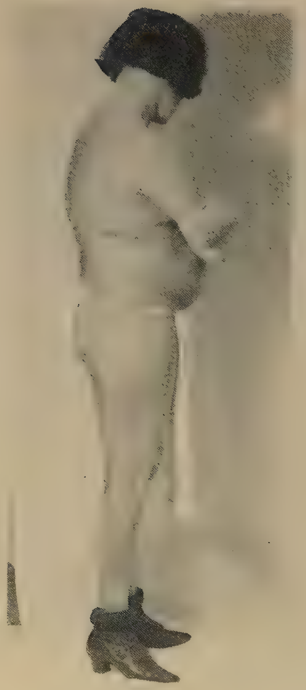
Children Taking Sun-Cure in Winter

Pulmonary Cases Taking Sun-Cure

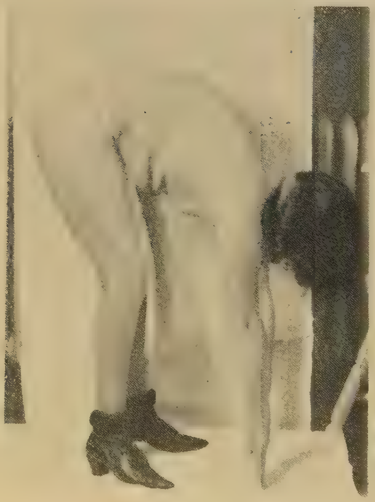


On entrance X Ray on entrance

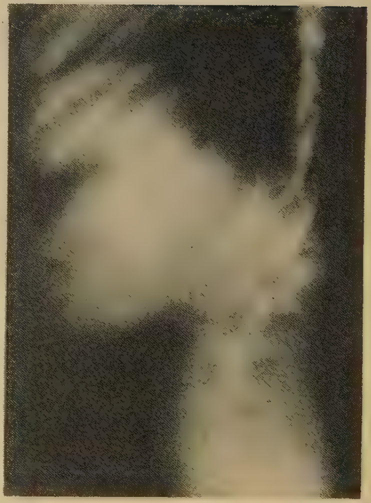
Case No. 4090: Tuberculosis of Spine. On Admission



15 mos. later

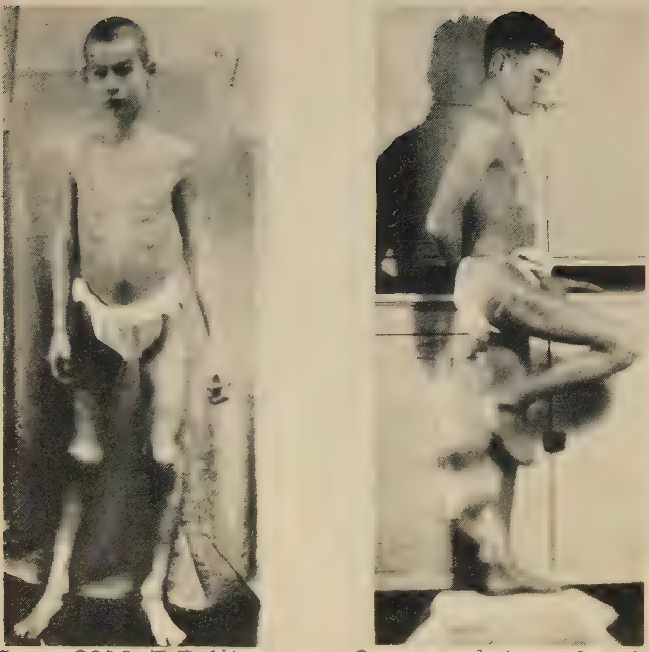


15 mos. later



X Ray on discharge

Case No. 4090: 15 Months Later



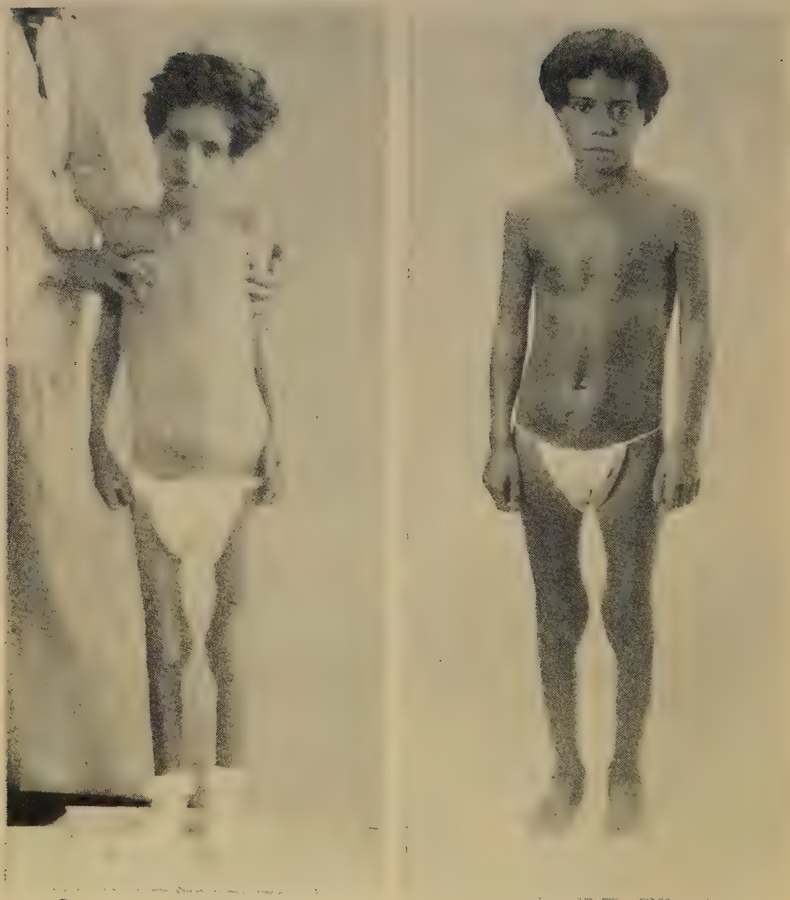
Case 2950 T.B. Hip on entrance

2 years later showing nutritional change and motion

X Ray on entrance

2 years later

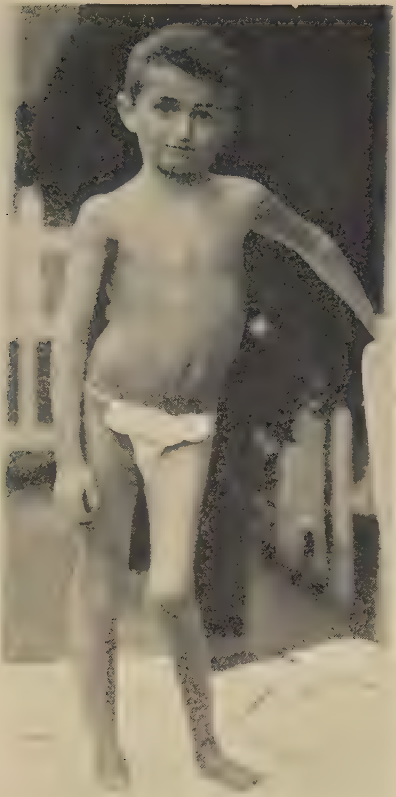
CASE NO. 2950: TUBERCULOSIS OF RIGHT HIP



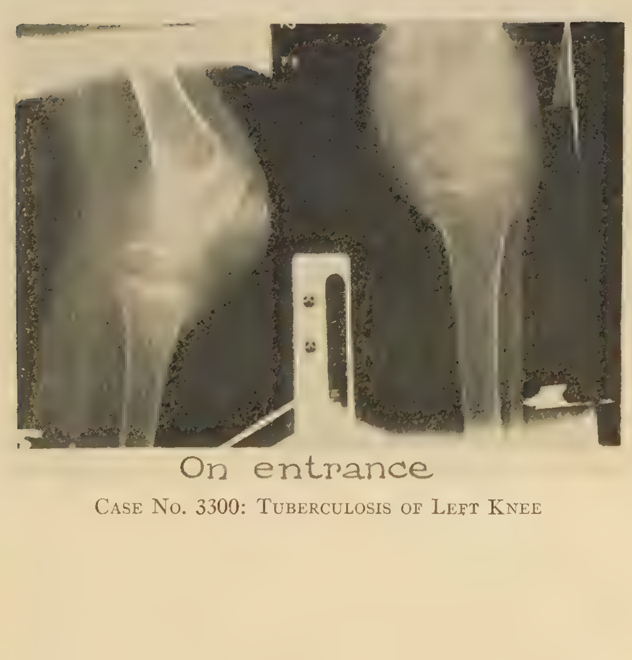
On entrance
June 1.- 1925

6 weeks later
July 13 - 1925

CASE NO. 4697: TUBERCULOUS PERITONITIS

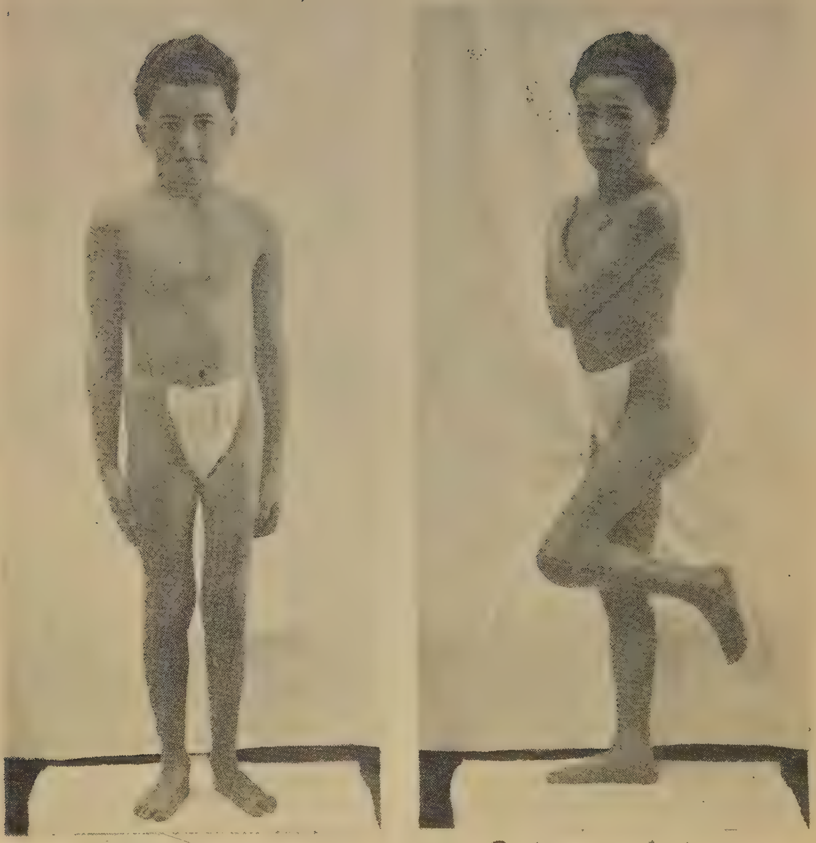


On entrance



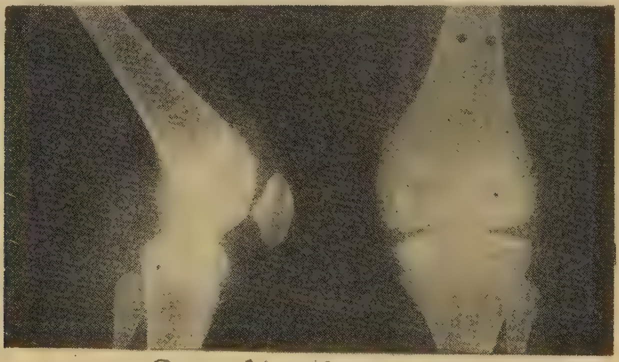
On entrance

Case No. 3300: Tuberculosis of Left Knee



On discharge

2 years later



On discharge

Case No. 3300: On Discharge (2 Years Later)

THE PROBLEM OF PREVENTION OF ACCIDENTS CAUSED BY THE USE OF MOTOR VEHICLES

ROBBINS B. STOECKEL

Commissioner of Motor Vehicles, Connecticut

THE AUTOMOBILE AS A TRANSPORTATION MEDIUM

The automobile was originally a pleasure vehicle

Twenty years ago the automobile was still used solely for pleasure. No one had any thought that here was a vehicle which in such a short span of years would revolutionize life through the character of its transportation facilities. Each of the first automobiles was a vehicle of adventure and served its owner for little if any practical purpose. If it be broadly stated that two decades ago, an automobile was considered a rich man's toy, it will hardly be an exaggeration. Its rapid development followed the demand caused by its expanding use. The complete history of its evolution has never been adequately written, and is perhaps still too young to require such treatment.

But by its merit, even over poor road surfaces and in spite of manifold imperfections, it has gathered more and more friends. Business has not been slow to foresee its probable development and the growing demand has been met by increasing manufacture: followed by greater sales distribution. Then having created its adequate supply, the demand has expanded until today the motor vehicle is brought into the daily life of every person who goes upon the highways and streets. Its use affects each person whether, as the old legal documents have it, "on foot or on horseback" or more modernly, in a vehicle.

How the automobile has changed life conditions

In passing, it is but fair to review some of the more important adjustments of life which the automobile has caused.

Its development has been the outstanding agency for making better highways and streets, beginning with surfacing and, as vehicular weight increased, going on to heavier and more permanent road foundations.

Through the opening of roads into new fields, especially through country towns and villages, it has increased values of suburban real estate, for through its use it has become possible for its owner to live farther from his work. At the same time it has stimulated markets by making the farmer's produce and manufacturer's goods readily available to a marketing center from greater distance in less time.

So also it has provided for the professional man—the man who sells time—more time to sell, and has made it possible for him to do more work over greater fields.

In addition it still retains its original pleasure use, but this is now secondary. There is hardly a car today which is not used mainly in business; but it is also the business man's holiday vehicle. Of the cars in Sunday or holiday traffic nine-tenths are cheap and medium priced second hand cars. The automobile is no longer the exclusive pleasure vehicle of the rich. It has become the predominant outdoor recreation medium of practically everybody. Mr. Everyman takes his family riding, into the woods, to swim or fish at the seashore, to enjoy the views of the road. So thousands of persons who never got it before, get a breath of air and a change of environment, and something new to think about.

The automobile is teaching the nation to play by making play available, and through the demand for amusement it is causing states and cities to open camps, playgrounds and beaches.

Who shall say that its use, in its manifest benefits to mankind, does not compensate for all the danger, damage and injury done by it!

Lastly it has become a serious competitor of the railways in both passenger and freight hauling. It is the public service vehicle of the times. It is the store delivery medium. Almost, it might be said of it that as a vehicle it is at the present time "all things to all men."

Motor vehicle registration increase in United States

YEAR	REGISTRATION	GAIN
		per cent
1920	9,231,941	22
1921	10,463,295	13
1922	12,238,375	17
1923	15,092,177	23
1924	17,591,981	17
1925	19,843,936	11

Distribution of motor vehicles—"saturation point"

Is it any wonder then that, with all these opportunities for use, it is in supreme demand and that no other development of any vehicle has, in the memory of man, been so fast or so complete. Its manufacturers have made cars cheap and reliable. Its transportation value has made its placing so universal that it is now an axiom that the distribution of motor vehicles is governed by population.

Averages of persons per car still vary by location but they are drawing together and even now the range is within close limits. Any state in the Union can, if necessary, take its whole population, and some of their belongings, put them into its registered cars and move them all at once to any point. One car to three persons is still uncommon, one to four and five is common, and six is the rule. It would seem that the so-called "saturation point," which will be primarily governed by economic principles rather than by road space, is around the first figure.

Area, population and motor-vehicle registration of the United States compared by groups, for 1924

SECTION	NUMBER OF STATES	AREA	POPULATION	REGISTRATION
		square miles		
Eastern	13	226,411	36,532,303	4,880,044
Middle	14	831,252	40,449,787	7,465,258
Southern	13	1,016,615	27,224,351	2,954,529
Far Western	9	952,550	9,295,485	2,299,694

Summary of conditions

All of which, if it has accomplished the purpose intended, presents a picture of good highway systems which open up all parts of the country, fine road surfaces, scientifically graded and built for traffic; covered with big, medium-sized and little cars of all kinds and makes; driven by people good, bad or indifferent, and crowding in with them all the lesser units of travel, the horse and wagon, the man afoot, the bicycle and here and there domestic animals, such as dogs, cats, chickens, cattle and sheep.

The automobile is the modern vehicle serving the modern man. It is a better transportation vehicle than he has ever had, makes him more efficient in business and provides him more recreation.

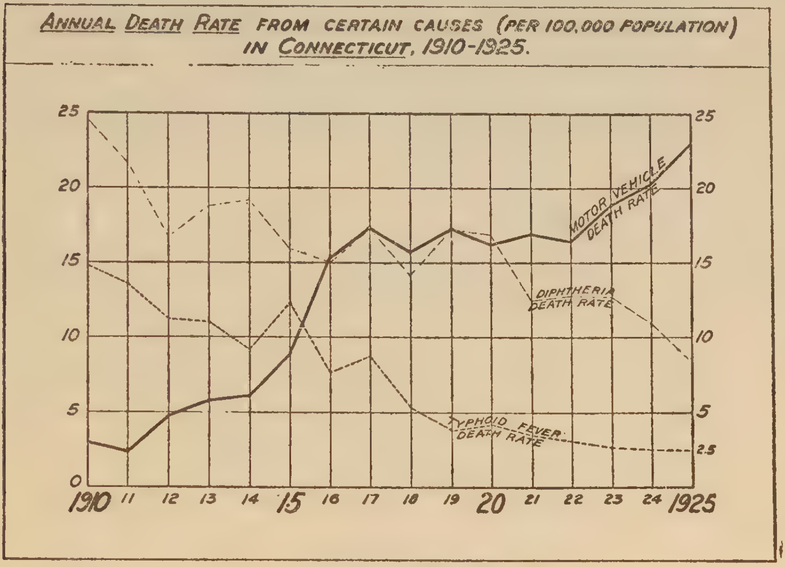
THE AUTOMOBILE IN TRAFFIC ACCIDENTS

Traffic accidents as a part of public health

No question of the times, so far as the public is concerned, exceeds in importance the problem of how to cope with the dangers created by the participation of the motor vehicle in the routine of daily life. The traffic accident is a part of the public health problem. It may be that it has not been always so considered but a general comparison of figures and of the causes which endanger health and life certainly must now take into account this great destructive agency. As compared with smallpox, diphtheria, typhoid or with any other epidemic disease and as compared with accidental injury and death from any other cause, it runs close to the top, with every prospect of heading the list within another year. So its place and right to consideration in every public health movement in the future is assured and those health agencies and organizations which have as their special duty the general supervision of the public health, will all take active interest in it. It is not a situation where the development of a specific is indicated, but the type of man capable of applying the methods and plans which have produced such is needed. The best brains available are none too good.

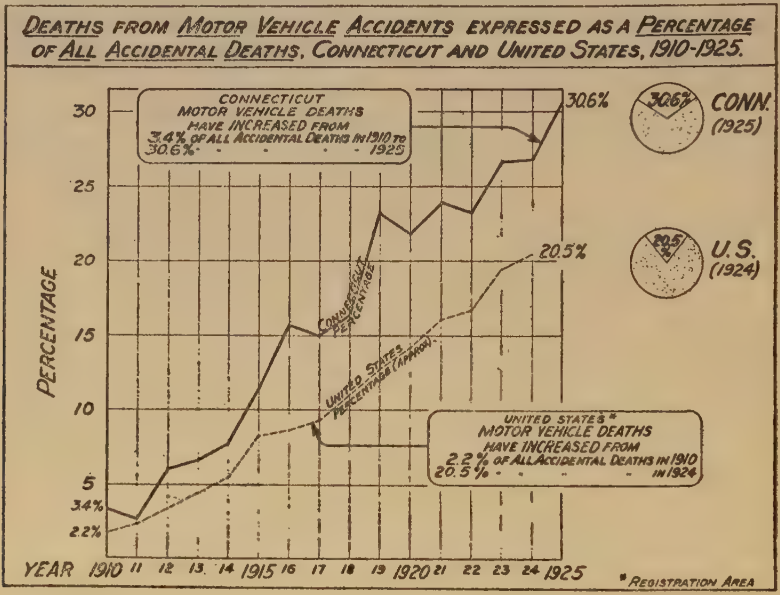
Hazards

Along with, and caused by, the immense use of the automobile, growing more extensive every hour and day, are the complications and emergencies which the public has had to meet. Each individual, whether a walker, a rider or driver of a horse or bicycle, or the operator of a car, has had a new problem to work out, a new hazard to cope with, in a new environment. This environment, which includes all movement on streets and highways is known as traffic. It is probably only natural and to be expected that, during the time in which experience in how to survive is being acquired, there will always be many misunderstandings and slips. The majority of these will cause inconsequential damage, but some at least will cause serious and mortal injury.



Responsibility

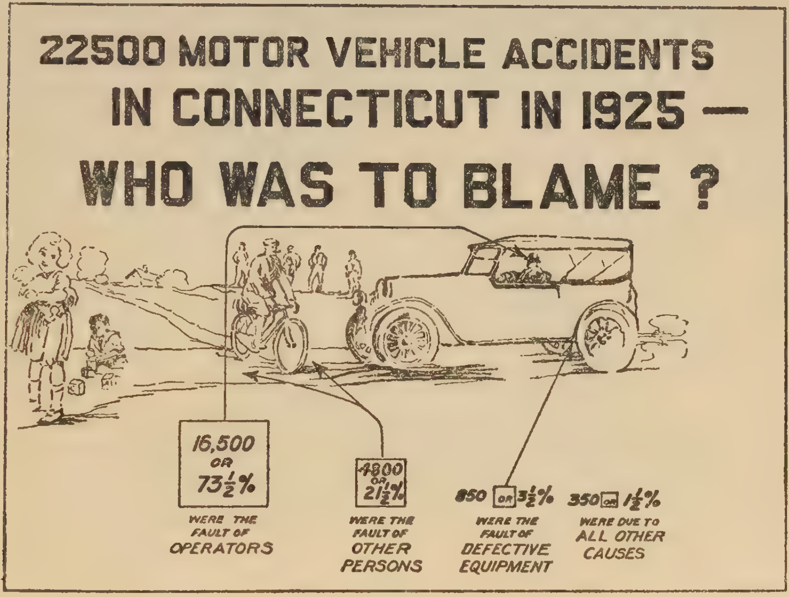
The new vehicle which has created the situation, and its responsible operator, are in the limelight, and blame will, prima facie, attach exclusively to them. The automobile is the fastest and easiest controlled traffic vehicle, so the legal principle of reasonable care is insisted upon to a degree where its operator is, to all intents and purposes, obliged to look out for everyone else. In traffic *he* has the most dangerous medium so *he* must assume the greatest responsibility, must exercise commensurate care to emergencies and keep the status safe. In other words, the use of every car is limited by the requirement, both in morals and in law, that such use must be safe.


DEATHS FROM MOTOR VEHICLE ACCIDENTS EXPRESSED AS A PERCENTAGE OF ALL ACCIDENTAL DEATHS, CONNECTICUT AND UNITED STATES, 1910-1925.

The necessity for statistics

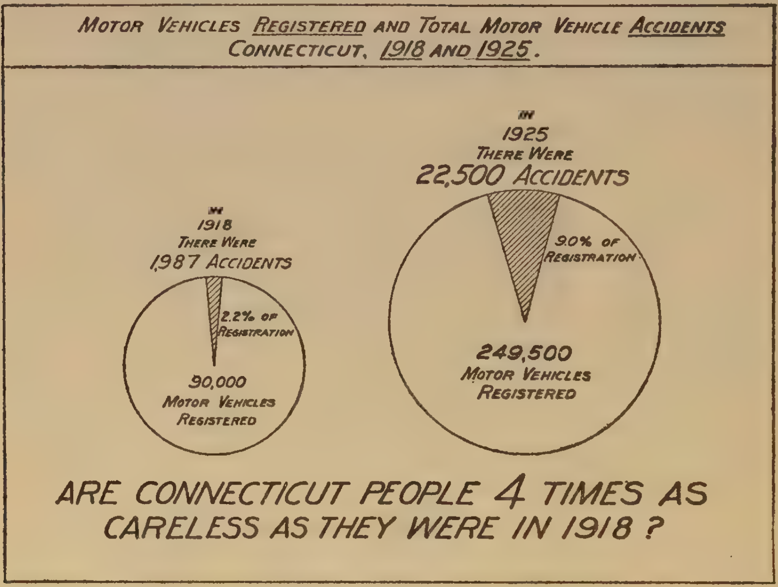
Drawing upon experience in other fields, more particularly following the lines laid down by the medical profession for stamping out epidemics, the first thing, obviously, is to secure a diagnosis; in this problem that amounts to statistics, to the study of causation, to learning everything possible about the situation and those particular agencies which are contributory.

One or more states and several cities commenced, as early as 1917, to gather such information and since then there has been a gradual gain in the number until today the field, in great traffic centers, whatever their territorial limits, is well covered. But there has been no standardization as to how to get the facts. Some agencies gather only such as touch fatalities and personal injuries; others, only a few incidental facts. But it is fortunately the case that human nature and performance average about alike, so probably conclusions for any group can be drawn from the reliable statistics of any other similar group.


22500 MOTOR VEHICLE ACCIDENTS
IN CONNECTICUT IN 1925 —
WHO WAS TO BLAME ?
16,500 OR 73½%
WERE THE FAULT OF OPERATORS
4800 OR 21½%
WERE THE FAULT OF OTHER PERSONS
850 OR 3½%
WERE THE FAULT OF DEFECTIVE EQUIPMENT
350 OR 1½%
WERE DUE TO ALL OTHER CAUSES

Connecticut Statistics

Since 1917 Connecticut has kept adequate records. In the earlier days the system was not perfected and in the totals there was an appreciable escape; but now, for five years, it has insisted upon the production of the facts. Each individual, who has an automobile which causes accident damage of over $10 or any personal injury *must* report to the State within twenty-four hours. The department charged with the administration of this activity goes at it aggressively. It first clips all state newspapers on the theory that it is an unimportant accident which does not get some publicity. It notifies the operators involved of their duty and insists upon the filing of its report forms. It has powers to punish severely for failure to do so. After three years of this, it is conservative to state that 90 per cent of all accidents are fairly reported; obviously the remaining 10 per cent is the minor accident class. So there is a body of figures upon which conclusions can be based.



THE REMEDY

Almost every accident has three constants

With but few exceptions there are at present involved in every automobile accident, three participating agents without which the accident could not have occurred. These might be considered the constants of the entire problem. They are: (1) the car, (2) the highway or street and (3) the operator. It may be interesting to briefly analyze the first and second before proceeding to a consideration of the operator as the most important.

The car

It is easy to see where the car, so far as it is built for safety, has made tremendous strides until at present, according to statistics, it is ahead of the accident situation. Its essential safety parts have been so perfected as a result of demand and of sales competition that at present, except in one or two rather obscure matters, no further improvement is needed. The car is good enough in its safety mechanism. It is perhaps a fact that it is too good, that it sometimes acts as a stimulant to the confidence of the driver and urges him to go beyond his capacity and impels him, through over-confidence in control, to errors in judgment. In any event, it is hard for a layman to see how the car manufacturer can greatly better its vital safety parts. In recent years the fashion and the demand has turned to closed pleasure cars. In many of these there is still too much body construction within the field of the driver's vision. A pedestrian, especially a small child, can be obscured from sight by either of the two front support posts. The cabs of many of the larger type trucks, closed in winter, shut off sight to a dangerous extent. This is a feature calling for the attention of body builders.

Motor vehicle registration increase in Connecticut

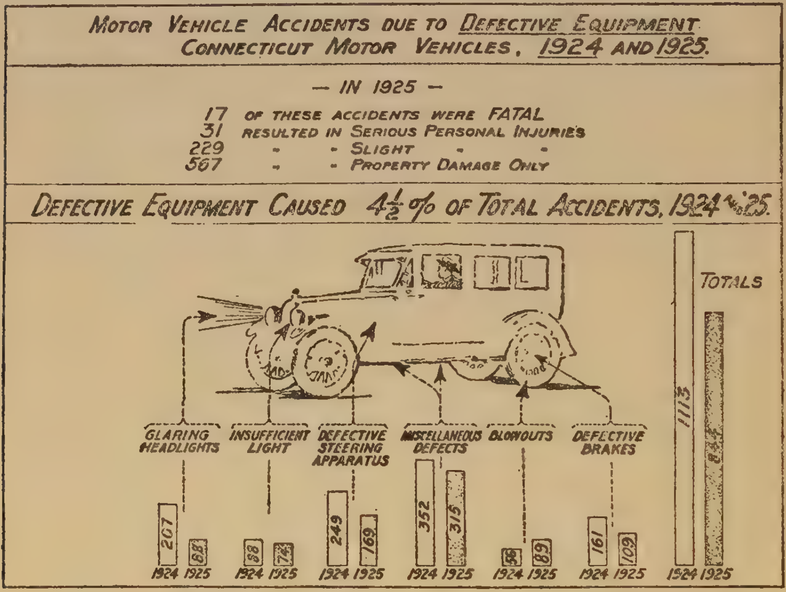
YEAR	REGISTRATION	GAIN
		per cent
1920	133,395	18
1921	141,466	6
1922	161,347	12
1923	189,566	15
1924	224,771	16
1925	262,564	14

Motor vehicle accident record in Connecticut

	1923	1924	1925
Accidents	16,500	20,781	22,568
Persons killed	280	302	354
Persons injured	4,879	7,158	7,992
Damage to property	$1,650,000	$1,878,000	$2,130,877

As a matter of law it is also well worth consideration because there have been several accidents where the owner was either held responsible or put to a difficult defense because his driver had his sight unreasonably obscured. A driver needs a wide field of vision. He should have it provided for him by the builder to the very utmost possible extent.

There are also certain accessories which are now proven safety devices and which every car should have. These include an adequate speedometer, a good windshield wiper and a good horn. Convenience and reliability in performance have added in most cases some sort of a signal device, usually good only for a cautionary signal intended to be used for safety when and where needed.



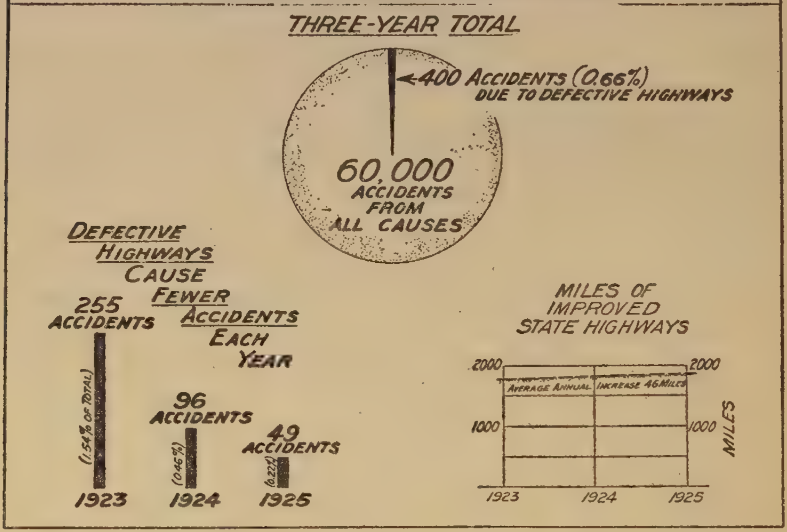
Speed is usually a factor in every accident, not necessarily a fast speed, but speed which was unreasonable for the time and place. There is proposed a scientific application of rules for safe driving which may be indicated by saying that one can only drive "as fast as he can see a clear course." This system provides a method for determination of what is a "clear course" in each case. This is mentioned because of the periodic attempt in some states and jurisdictions to install governors for the regulation of speed. It is often claimed by advocates of the governor system that if every car were restrained to twenty miles or so there would be no accidents. Elasticity of speed, even to a pretty fast speed, is an essential for safety. The driver ought not to be governed by any of his mechanisms; he should govern them.

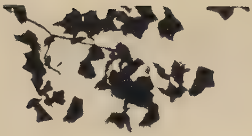
So much for the car; it is good enough and safe enough for anybody. So few accidents are now laid to defects in the car that it might almost be said that there are none.

The highways and streets

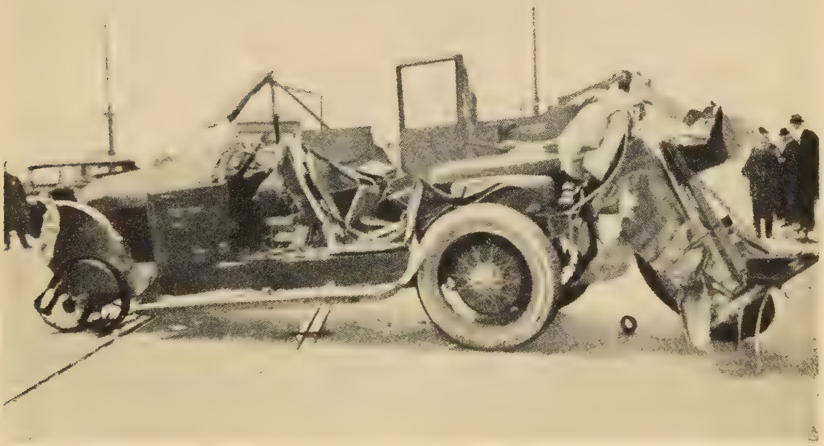
The engineer who builds a highway or street or who is in charge of its maintenance is in a position of trust for the safety of the public. He has not in the past received the credit due him. The safety problem was thrust upon him when he, in common with everyone else, had no traffic safety experience, when the capability of the new vehicle was unknown and when education in what might be expected of it was nil. His work has grown with the development of of the traffic and more and more, in every state, city and town, the authorities are spending money on what is now known as highway safety engineering. Even in the great conferences held on highway safety, his foresight and planning have been either forgotten or taken for granted. But be it said here that without him and his technical applications of common sense rules to highway and street, chaos, in the sense of death and destruction, would reign. He has a standard of construction for safety which if stated would be in effect that his road and highway must be so good, so well guarded, with such clear courses, that no emergencies by reason of the road can confront any automobile operator, and that if he gets into trouble it is, prima facie, his own fault. The operator must not be surprised by the road. He must be warned by signs, by traffic lines and by lights. Width must be provided where there is safety leeway enough for him to recover if he even slightly fails to grasp a warning or is so stupid as to disregard a plain danger confronting him. Recently transportation has demanded clearing of snow in winter. The engineer's job is an all-the-year-round, twenty-four-hour-a-day piece of work. Statistics indicate that his work is well done, actually accomplished, but being constantly bettered. A road may be rough at times, there may be an occasional bad place or even a bad section, but this long headed scientist usually has seen it first, and through some subordinate has put out special warnings. In street engineering in cities and large towns there is still a great deal to do for safety. Wherever there are recurring accidents in any locality, such as an intersection, engineering ought to be applied and correction made if needed. The accidents are either caused by some bad road feature or by a traffic fault. If the former, the engineer will correct it and if the latter, the police. One cannot be constantly pulling down buildings to secure sight lines or forever taking away obstacles for the sake of the traffic, but in every case where any permanent obstruction is to be placed, such as a gasoline pump or a new pole, the matter of traffic in relation to its proposed situs ought to be considered and the determination made with this thought fully in view.

NUMBER AND PROPORTION OF CONNECTICUT MOTOR VEHICLE ACCIDENTS DUE TO DEFECTIVE HIGWAYS, 1923, 1924 AND 1925.





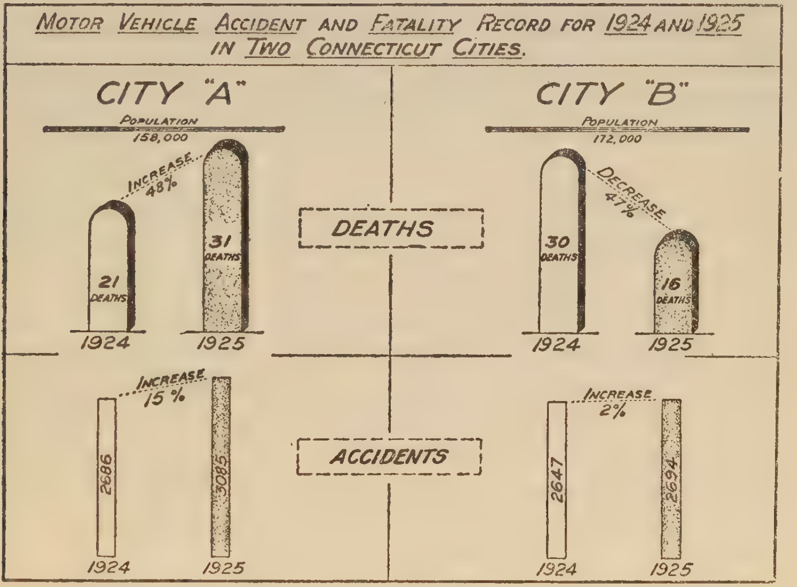
Application of Highway Engineering—Too Dangerous Underpass



"Failure to Grant Right of Way"—Five Young Men Killed

Public sentiment a necessity

No effective remedial measure of any kind, affecting any considerable number of people, enough to call a public, has ever started or arrived anywhere without public sentiment. And with the automobile accident situation confronting them people have talked, theorized and debated, but until 1916 no sentiment strong enough to do anything had arisen. About that time, it was strong enough to start a movement in some eastern states, and simultaneously, in some of the larger cities of the west, to see what, if anything, might be done. This movement be it noted has begun in those places where there was the most traffic in the smallest territory.



INTENSIVE SAFETY WORK IN CITY "B"
VERY LITTLE SAFETY WORK IN CITY "A"

Education

Education of the whole group of participants in traffic is proceeding about as fast as possible. The adult learns mainly by experience and the education which he receives tends to make him a little more of an average human being. Traffic is no place for persons with idiosyncrasies.

The child needs careful character teaching, not along special lines but for the development of those traits which will help him do a good traffic job. The principal one is to teach concentration.

Discipline

Discipline is a part of education and ought to extend to the pedestrian, the bicycle rider, the team and horse driver; each should be charged with the duty to keep the traffic safe, and be punished if he fails to do so. A pedestrian or other participant than the operator who persists in being a fool in traffic can and must be punished.

The operator

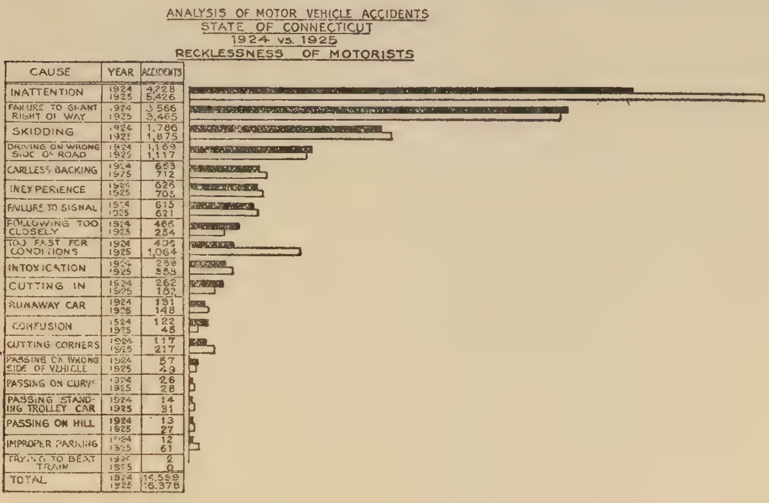
But after all effective education and discipline must be specifically concentrated upon the motor vehicle operator. He is the engineer in charge of an engine capable of causing death and destruction. There are more than 20,000,000 operators driving motor vehicles in the United States. An adequate inquiry into their qualifications would need to include an intelligence test and general sizing up of each individual, for the automobile is a fine medium for the testing of character. A man who on account of his nature, "hogs the road," is as dangerous as one who does the same through inadvertence or carelessness. Eighty-five per cent of all operators are good. Fifteen per cent of all operators are bad.

The annual increase in number of accidents and in injuries, death and damage to property is chargeable in the main to the reckless operator. The car and the road are more than reasonably good. They are not to blame in any considerable number of cases.

Recklessness

Recklessness in its motor vehicle sense means a wilful disregard of safety, or else such bad judgment, heedlessness or carelessness as to amount to the same thing. For instance the business man who drives his car along through traffic while he is mentally working out an abstruse business deal is as guilty, or ought to be, as the joy rider.

Recklessness, except in a minor per cent, is really a failure to concentrate on the business at hand, that is, on the driving. When major instances of recklessness are surveyed, plain "heedlessness," "inattention" (that is attention to something else), "failure to grant right of way" and all the other forms with which everyone has had patience and from which we have suffered so long, are the same thing. Each is a failure to grasp a situation and to perform correctly. It is a cause for shame to have an accident. When drivers of the same experience are compared and one has had accidents while the other has not, any impartial person will judge the first inferior in brain capacity.



CAUSE	YEAR	ACCIDENTS
INATTENTION	1924 1925	4,228 5,426
FAILURE TO GRANT RIGHT OF WAY	1924 1925	3,566 3,465
SKIDDING	1924 1925	1,786 1,875
DRIVING ON WRONG SIDE OF ROAD	1924 1925	1,169 1,117
CARELESS BACKING	1924 1925	653 712
INEXPERIENCE	1924 1925	626 705
FAILURE TO SIGNAL	1924 1925	615 621
FOLLOWING TOO CLOSELY	1924 1925	466 254
TOO FAST FOR CONDITIONS	1924 1925	406 1,064
INTOXICATION	1924 1925	289 359
CUTTING IN	1924 1925	262 187
RUNAWAY CAR	1924 1925	131 148
CONFUSION	1924 1925	122 45
CUTTING CORNERS	1924 1925	117 217
PASSING ON WRONG SIDE OF VEHICLE	1924 1925	57 49
PASSING ON CURVE	1924 1925	26 28
PASSING STANDING TROLLEY CAR	1924 1925	14 31
PASSING ON HILL	1924 1925	13 27
IMPROPER PARKING	1924 1925	12 61
TRYING TO BEAT TRAIN	1924 1925	2 0
TOTAL	1924 1925	14,559 16,378

Recklessness of Operators in Connecticut

The same line of reasoning applies to pedestrians and to other users of the highway. Safety results might first be expected from the pedestrian because of his defenselessness. The only universal betterment which can be expected will come from the fact that as the situation in traffic gets worse and worse, the minds which have to deal with it will direct more and more attention to actual performance and we shall have constantly better drivers. What then can we do about the present situation?

Elimination of the unfit

To correct and eliminate the unfit is a proper function. It is effective. The National Safety Council and the Committee on Street and Highway Safety both arrived at the conclusion that the Eastern States which have licensing systems, and as a result can refuse an operator a license, have better accident records than the others where this is not so, by at least 15 to 25 per cent.

In the minds of those who have the work in hand, including most of the state administrators of motor vehicles the course to be followed and the remedy to be applied to the person who is reckless is clear. It can even be almost reduced to a formula. It can be well and adequately carried out by a state authority only.

The recommendations to overcome recklessness

The following recommendations if adopted will lead to a reduction in this evil.

1. Make a system of operators' licenses with an examination into fitness to drive which will include:

a. Brain capacity (an intelligence test).

b. Actual driving test.

c. Examination in the law and rules of the road.

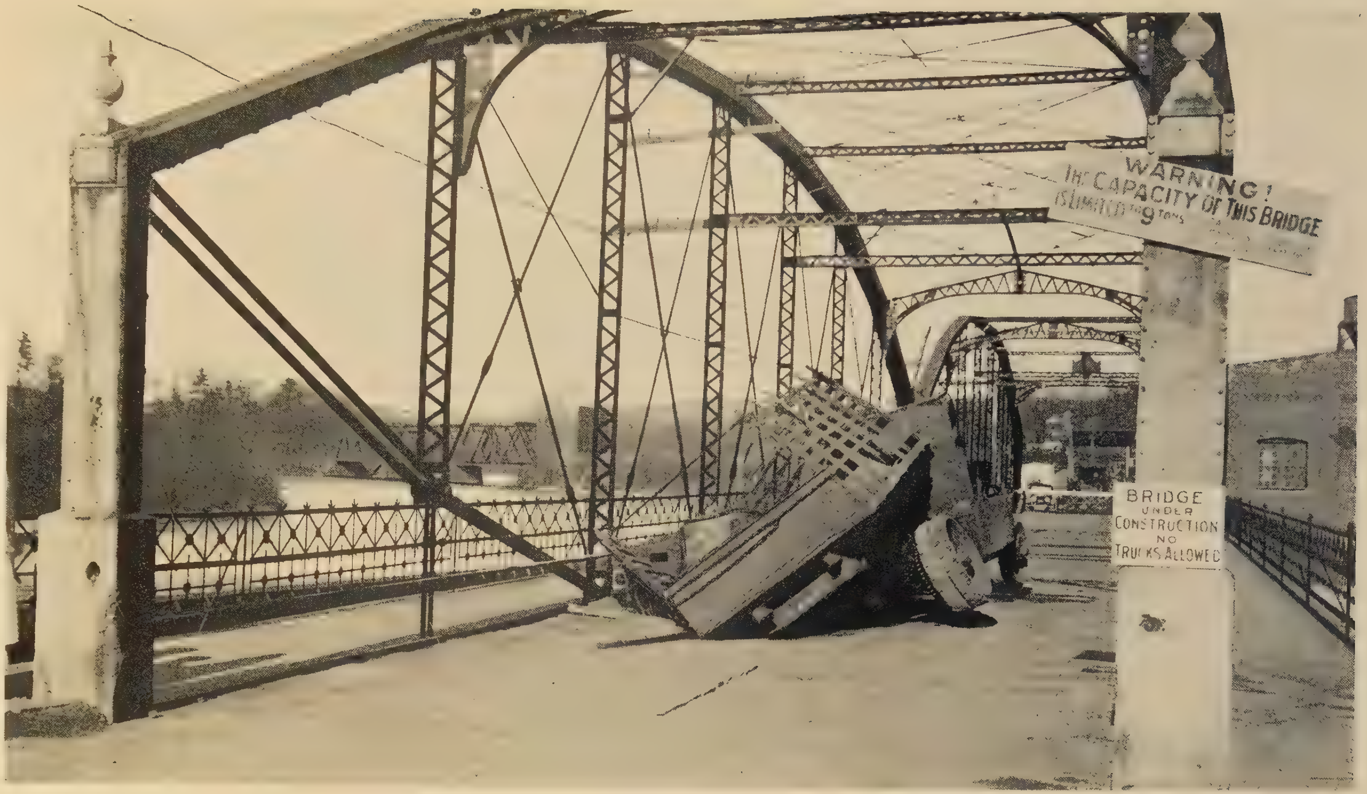
d. Educational qualification (to read and write).

e. Special tests for defectives (partially deaf men, men with one arm, etc.).

Note: The general rule for a defective should be that "unless, notwithstanding the defect, a man can operate as well and safely as though he had none, he should not be passed." This makes allowance for compensation of senses.

2. Provide an accident reporting system of all accidents so as to secure a body of statistics for the state of operation. Get these into proper forms for analysis and study; send information back to the localities where accidents are reported and suggest remedial work where it is apparent.

3. Provide a system of traffic courts under state appointment of judges and provide that each conviction for a traffic offense be forth-



Result of Disobedience to a Warning Sign

with reported to the state authority together with the fine imposed; the money so taken from fines to be put back into the court system. A traffic court is not meant in the sense of a small violation jurisdiction. This court should be a high court where a real trial could be had and where only cases of reckless driving or other driving dangerous to the public could be tried; where a defense could be properly introduced and insisted upon and acquittal be had, when just. These traffic courts should have the power of recommendation to the state authority, should be able to imprison for wilful offenses and to punish severely by fine. A part of each case should be, unless obviously unnecessary, a general sizing up of the offender by the judge as to his mental capacity. In doubtful cases medical or expert advice should be available and the recommendation of the court should be followed in granting licenses. Imprisonment and fine and suspension of license for at least a year should follow the offenses of driving while intoxicated, evading responsibility and repetition of reckless driving. In all other offenses the court should exercise the broadest jurisdiction, bearing in mind that the attempt is to take off the highways any persons dangerous to the public.

4. The state authority should exercise absolute power on all matters of license suspension. He will be immediately checked if he abuses this power. He should have his own court and, subject to appeal to a high state court, should determine all suspension cases.

5. Suspension of registration, taking up tags, should be granted as an additional check and the state authority should have the power to refuse to register any person who has demonstrated his unfitness with a car.

By the exercise of such powers the percentage of reckless drivers can be lessened, and as public sentiment grows, reckless driving will become a byword and care will, to some extent, take the place of carelessness. In many states this program is well under way.

One or two general observations will close this paper.

No admitted state safety authorities

The first is that no state has as yet openly constituted any body as its safety authority. In most states the authority in control of motor vehicles is so considered but never, so far as known, has any appropriation been granted by a state for anything except the specific purpose set forth in the act of appropriation. As a consequence there have been no funds available for the investigation of the best method of compiling and using statistics.

Defects in statistics

All automobile accident statistics are as yet defective because none of them take into account the total number of miles operated by the cars or the total number of accident hazards encountered by them. These can be had. The mileage can in most cases be approximated closely from the gasoline tax returns by securing the average number of miles per gallon and the total gallonage. The hazard must then be defined and traffic counts made. Then accident frequency can be determined.

Special investigation needed

Special technical investigators are needed to develop and work with the state and other officials in charge of this problem, especially to classify procedures and their results, to detect and remedy mistakes and in general to act as checks on useless expenditure of money and time.

There is nothing hopeless about this accident proposition. It involves everybody, so everybody will have to help correct it. Those who can be must be educated as promptly as possible. Those who cannot or will not be educated, must be disciplined. The unfit must not be qualified. The reckless must be taken off the road. The problem is solvable only by moral teachings plus law and rigid enforcement.

WILLIAM FARR

SIR ARTHUR NEWSHOLME

Late Principal Medical Officer of the Local Government Board of England

To the younger generation William Farr has become, as the French say, merely the name of a name; and many of my hearers might be excused for not knowing that it was by his life work that vital statistics in England assumed a supremely important rôle in the promotion of public health reform, and England set an example to many other countries by initiating means for measuring the chief events of life, for ascertaining their local incidence, and by thus enabling action to be taken on accurately ascertained facts.

In the year 1839, Farr's special life-work began at the General Register Office, London, soon after the passing of the National Registration Act, which made it obligatory for births and deaths to be registered. Prior to this some attempts had been made to record "matches, hatches, and dispatches"—in London and a few other English towns. The most noteworthy of these were the London Bills of Mortality, inaugurated to diminish the terror caused by invasions of Plague, by the substitution of accurate returns for panicky exaggerations; and there is on the table a study of these Bills of Mortality by Captain John Graunt, published in 1683, with many quaint and shrewd deductions from the tabulated data of burials and christenings in London. Graunt indeed has been described as a scientific Columbus; but if so, Farr must be ranked with William Harvey in Physiology or with Lavoisier in Chemistry; for to his scientific analysis of the national data rendered available under the national system of registration, and especially to his studies of the causes of death, of their relative incidence in various localities and in different circumstances and especially to the vivid writing by which he succeeded in compelling attention to the records, Farr was a chief architect of the public health administration, which during his life-time was built up chiefly by three men, Edwin Chadwick, John Simon, and Farr himself.

The records of births and deaths only receive their full value when stated in terms of population; and the way for Farr's life-work was prepared by the first of a series of decennial censuses in 1801. It is significant of the mental attitude of the times that the taking of this census was opposed, among other reasons for fear that some plague such as the Israelites under King David experienced would result from this blasphemous procedure.

William Farr was born in 1807, and began his chief life-work thirty-two years later. He was born in a small village near Shrewsbury and was adopted by a friend with the consent of his humble parents, this friend subsequently leaving him enough money to go to Paris in 1829 and spend a year or two there. While there he was near being shot in the gardens of the Palais Royal in the Revolution of 1830 and then fled to England. Returning to Shrewsbury he acted for six months as an unqualified *locum tenens* house surgeon at the Shrewsbury Infirmary. That he fulfilled his duties satisfactorily is shown by the following testimonial and a snuff box which were given to him on his departure. Its date is probably 1832.

Dear Sir,

We the pupils of the Salop Infirmary being desirous of expressing our gratitude to you for the very marked attention you paid us during the time you officiated as House Surgeon, as well as for the readiness and ability with which you promoted our professional studies, beg your acceptance of this small present as a token of our united regard and esteem. With our best wishes for your future prosperity.

We remain
Dear Sir,
Yours very sincerely,

(Here follow the signatures of 9 medical pupils at the Infirmary.)

Probably we owe it to the fact that Farr still had not obtained a medical diploma, that he did not become surgeon to the Shrewsbury Infirmary, for which position he was favorably considered.

But let us glance at his work in Paris, which almost certainly determined his future career. Farr attended lectures by Orfila and Louis in medicine, and by Andral in hygiene, and it was at this time that the study of hygiene, of medical history, and of medical statistics began to engross his interest. At this period no medical student would have thought of visiting any other place than Paris in order to finish his medical education. A great medical triumvirate dominated the Paris Medical School, consisting of Andral, Chomel and Louis. It was the day of revolt against doctrines and the substitution for these of clinical observation and pathological findings. It was a day also in which Laënnec had shown how by the stethoscope some of the findings of the autopsy might be diagnosed during life. It was furthermore the day in which Louis was teaching the value of medical statistics, and was demolishing for instance, by their means the case for the blood-letting of patients which then prevailed. Andral's lectures were full of eloquent statement of facts, in which he supported firmly Louis' numerical method of study, showed himself an arch-enemy of hypotheses, and made the new and more exact study of medicine attractive to thousands of students.

I have on the table a note-book written by Farr in 1830 while in Paris. It is full of annotations relating to the methods of hospital administration and relief, to the history of medicine, etc.

Andral was thirty-three years old when Farr went to Paris, and two years earlier Andral had been elected to the professorship of hygiene. It may almost be said that Andral and Louis made a *tabula rasa* of the older medicine and proceeded to build a science based on exactly ascertained facts accurately stated in numerical order. Andral was one of the editors of the *Annales d'Hygiéne Publique et de Med. Lég.* Although documentary evidence is lacking there can be little doubt that Farr's bent towards hygiene was largely influenced by his contact with Andral. This bent continued and became more intense; and as we shall shortly see it was the motive showing itself in great intensity in all his official reports to the Registrar General.

Nor can there be any reasonable doubt that Louis had a great influence in determining the direction of Farr's hygienic inquiries. Like Louis, Farr became possessed with the determination to measure and assess the quantitative value of each medical fact; and by such facts, collated without any *a priori* views to test the value of every hypothesis.

Louis may I think be rightly described as the father of medical statistics, as Farr was of vital statistics; and in following the course just indicated, they were both adopting the advice of Sydenham, the father of clinical medicine,

> In writing the history of diseases, every philosophical hypothesis which has predisposed the writer in its favour, ought to be totally laid aside, and then the manifest and natural phenomena of diseases, *however minute*, must be noted with the utmost accuracy.

Louis was imbued with this ideal of accurate observation, improving on it by giving each fact conjoined with like facts a numerical value.

The need for such numerical analysis of facts was emphasised by him as follows:

> Quand je me suis fait une idée, *à priori*, des faits non encore analysés, j'ai toujours vu, après cette analyse, que mon idée, à priori, etait fausse.

On Farr's return to England, he spent some time in Shrewsbury, as already mentioned; then went to London, where he took his L.S.A. in 1832, and this humble qualification was the only one possessed by him until he became the recipient of various honorary degrees.

In 1833 he married his first wife, and began to practise in London and supplemented his earnings by teaching medicine. There is before you *The British Medical Almanac*, 1837, edited for several years by Farr, which on page 84 contains an advertisement of his lectures on "Hygiene and Medical Jurisprudence," the subjects in which Andral had specialized. He contributed to the *Lancet*, and was also editor of the *British Annals of Medicine, Pharmacy, Vital Statistics and General Science.*

There can be little doubt that the appearance of the words "Vital Statistics" in the last-named title was at Farr's suggestion; and both the above-named publications give valuable indication of Farr's already great skill in medical statistics and of his learning in the history of medicine. The volume of the *Almanac* for 1839 contains a full, though summarized, "History of the Medical Profession and its influence on Public Health in England." During the same period he contributed an article on "Vital Statistics" in McCulloch's *Account of the British Empire*, which was not extravagantly described by Mr. Noel A. Humphreys, for many years Farr's able colleague and assistant in the General Register Office, as "the foundation of a new science," the alphabet of which had been framed in the commentaries of Captain John Graunt (1620–1674).

The writings just named gave ample evidence of exhaustive research, and incidentally illustrated his capacity for picturesque and fervid writing, which conduced so greatly to his influence through life. Thus in the preface to the Almanac for 1839 referring to the recent establishment of the Central Office for collecting vital statistics he says:

> Death still knocks at every door in some garb, and tears our best friends away from our hearts and household hearths, in the vigor and fresh blossom of life. If the secret roots of death were once pointed out by authentic observation, the human frame might be prolonged to its full ripeness, until it fell as gently as a plant upon the earth.

In the same volume in a chapter on the History of the Medical Profession, referring to the College of Physicians in Harvey's time, he notes the list of Fellows, and then writing of the inferior order of Licentiates comes the following sentence:

> In the midst of ten licentiates, crowded at the bottom of the page in the Pharmacopeia, there is one declared totally unfit to be a fellow, and only serviceable in *some cures*, yet an Englishman by birth, a Fellow of Oxford, and a graduate of Cambridge—one sufficiently learned, and of competent age and gravity—Sydenham.

A little earlier in this same volume (p. 166) referring to medieval miraculous cures he quaintly observes that "the principle of the division of labor was applied to the saints."

Farr was a sound classical scholar; and he was early inclined to the giving of new names to subjects and diseases, some of which remain in current medical nomenclatures. The term "enthetic" for inoculable diseases was, I think, his invention; so certainly was "zymotic," applied to all infectious diseases, a term which anticipated a line of thought similar to that of Pasteur. A knowledge of fermentation indeed has been the foundation on which the science of the pathology of infectious diseases has been built.

He was less successful with the name "Hygiology." He objected to the word Hygiene, as a naturalised French word, not agreeable to the ear, though in advertising some early lectures (p. 84 of *Almanac* for 1837) he used the term Hygiene.

Two of these lectures were published in the *Lancet* (vol. i, 1835–6, pp. 240 and 773). In the first of them he gave the first census in the world's history as that of the Israelites in the second year after they came out of Egypt; and while deprecating "the revolting practice of Sparta of destruction of weakly infants," suggested that if infant mortality had been greater in England and "many of the weaker children had perished, is it not probable that the mortality in manhood would have proportionately declined?" With our present knowledge we can confidently answer this question in the negative, and it was so answered by Farr himself in the 30th Annual Report of the Registrar General in the following words:

> The very conditions which diminish the numbers killed in the battle of life diminish the numbers of wounded; and as every single death by violence implies the injury or mutilation of survivors, so nearly all the zymotic diseases leave irreparable traces in the blind, the deaf, the weak in body or brain. By removing the discovered causes of death you at the same time remove conditions which prevent the progress towards perfection of the human race.

In his second lecture he gave a valuable study of Hippocrates and of critical days in disease, and in answering the question, "Why study hygiene when by promoting the general health it would diminish the number of patients?" stated "I know that our profession, will not, for a moment, harbor sentiments so base;" adding, "We exist as a body to promote the public health." It was with this sentiment as his pole-star that Farr was able during his official life to prepare the way for and to facilitate greater sanitary reforms than have occurred in any other period of human history.

The last quoted sentence gives the key to Farr's activity and success.

He was primarily and always a hygienist; running through all his great reports there is evident a burning desire for the welfare of man, and every branch of science is made to contribute to illustrate the mischief shown in the national statistics and to point to possible measures for alleviation.

Farr's lectures in the *Lancet,* and still more his contribution to McCulloch's volume led to his appointment in 1839 as "Compiler of Statistics" in the newly organized General Register Office. In 1837 Farr's wife had died from phthisis. She had been under the care of Sir James Clark, the Queen's physician, and Clark had secured Farr's help in bringing out a new edition of his volume on Consumption and Climate. Clark's influence doubtless helped in the appointment, and the energetic reformer Edwin Chadwick also had a share in recommending Farr for his new work. At this very time Chadwick was struggling with the Herculean task of poor-law and sanitary reform. At every step he was thwarted by lack of authentic information, especially as to "fever" and cholera, and he was also struggling to get beyond the conception of relieving distress to that of diminution of the diseases causing it. In Farr's appointment, a gigantic stride in both directions was taken.

The first report of the Registrar-General was published in 1839, and to this report Farr contributed the first of that long series of essays which have been the basis of the science of vital statistics in England. In these reports the mortality of every district throughout the country has been the subject of analysis. The attention of local authorities has been compelled to any special incidence of deaths in their districts. Medical officers of health have been created throughout the country, one of whose chief duties is to draw forcible attention to the local incidence of deaths, and recommend measures tending to decrease the sickness and death-rate. Where the local supervision has been lax, or the medical officer's recommendations have not been carried out, the Registrar-General's periodical returns enabled the medical staff of the Local Government Board to intervene and investigate any local outbreak of fatal disease. The publicity given to the Registrar-General's weekly, quarterly, and annual reports has evoked a spirit of inquisitiveness and even of emulation throughout the country; and the general result of the publicity secured and of the consequent efforts on the part of local authorities has been an immense improvement in the public health of the community.

For over forty years Farr devised the methods and supervised the actual compilation of our national mortality statistics, introduced methods of tabulation which have stood the test of time, and a classification of causes of death which has been the basis of all subsequent methods; and from these statistics, in reports year by year and in the classical Decennial Supplements written by him, deduced practical lessons as to the causation and prevention of disease, which have formed a most potent factor in determining the course of the sanitary history and the wonderful triumphs of public health in this country.

But some general observations as to the extent to which statistics are valuable and the inevitable limitations of this utility appear to be desirable at this point. The function of statistics is to sum up many individual experiences in a single statement, which will show concisely the tendency represented by the whole. Evidently quantitative statements dealing with numerous facts cannot be made without statistics. Homogeneity of data, implying accurate definition of each unit to be counted, is required, and it is because of neglect by the investigator in this respect or difficulty in definition, that so many statistical investigations are fallacious and their results are as shifting sand. Among the causes of error the personal equation of the observer himself is especially prominent. Happily in mortality statistics, where there is accurate registration, no serious error is likely to arise, except when comparisons are attempted between indefinite or grouped causes of death in various localities.

The chief immediate value of vital statistics for public health work *lies in the facts themselves*, pointing out premature death and sickness and unnecessary causes of death and their localization, and the circumstances in which they have occurred. Comparison between different experiences shows to some extent the degree of preventibility of mortality; and medical and hygienic knowledge, non-statistical in origin, gives exactitude to public health action.

In collecting his data Farr's mathematical skill, his logical mind and his medical learning enabled him to avoid most of the pitfalls into which amateur and desultory statisticians occasionally fall.

Statistics of disease as used by him were made to fulfil three essential conditions, viz., that:

1. The amount of the evil—injury to life and health—must be ascertained.

2. The evil must be localized, and its relative incidence displayed, according to age and sex, to locality, to social conditions, and in various occupations.

3. Public attention must be drawn to the facts as ascertained, and all possible ingenuity and even eloquence employed in securing this end.

The use of comparisons between duly corrected death-rates from all causes and from special diseases in different areas and for various social positions and occupations, threw a search-light on centres of excessive mortality at one or other period of life or from one or other cause. No branch of statistical work has been more fertile in result in the hands of public health workers, than this. The exact position of excessive mortality is thus exposed, and public health investigation and reform can be concentrated where most needed. This intensive study of vital statistics has proved especially valuable in child welfare work, the wards of towns, and even the streets in which child life is sacrificed have been revealed, and with this also the special diseases and the conditions giving rise to them have been laid bare. For instance, medical officers of health and even the general public are brought to realize the damnably soporific error underlying average death-rates for the whole country or for an entire town, and are pressing for information as to the areas of maximum mortality, and inquiring how the maximum may be lowered to the level of the minimum mortality already experienced. An important example is furnished by the enormous variations in different parts of England in the death-rate of infants in the first month after birth, indicating the vast scope for future application of preventive medicine to maternity and infancy.

A fourth and even higher object was manifested throughout Farr's writings, viz., that statistics were used to the extent of their possible utility in tracing the sources of disease and in throwing light on their causation. The statistical limitations of this object are well known. It is always necessary to check mass results by pathological facts and by the evidence derived from epidemiological investigation into individual cases.

The hygienic bent of Farr's pursuit of vital statistics was associated in all his reports with evidence of *eager desire for social service;*

and the axioms governing his inquiries to this end may be gathered by the following aphorisms from his first annual letter to the Registrar-General that "diseases are more easily prevented than cured," and that the first step in "their prevention is the discovery of their exciting causes." Farr's burning desire for social service was as marked as his statistical acumen; and he can worthily be placed in the glorious company of Howard, who reformed our prisons, of the workers, including Southwood Smith, Lord Shaftesbury and others, who secured the mitigation of the evils of factory and mining life, and of Edwin Chadwick and John Simon, who were pioneers in Poor Law and sanitary reform. In the earlier reforms affecting prisons, factories and mines, it was not the economic motive—although this was a powerful instrument in Chadwick's hands—so much as pity and religious motive which secured reform; and similarly in the most severely scientific discussions in Farr's reports the humanitarian motive and driving power constantly emerged.

Epidemiological work. The Registrar-General's statistics as to weekly, quarterly, and annual incidence of deaths from the chief infectious diseases during the 85 years of civil registration form an invaluable series of epidemiological data, while the corresponding figures for sickness since 1911, compiled in the Central Government Department for Health, give data of rapidly increasing epidemiological value. Farr early recognized that an epidemic is subject to definite laws, and that, for instance, a great epizootic like cattle-plague has its regular period of rise, of maximum, and of decline irrespective of human action concerning it. Farr's first note on this subject is in his Annual Report for 1840, and in a letter to the *Daily News* in 1866 he clearly enunciated this principle of spontaneous subsidence of epidemic diseases.[1]

This does not necessarily imply that against diseases pursuing when uncontrolled the normal epidemic curve the hygienist is helpless. When, as in the case of smallpox, specific immunity can be secured by vaccination, the epidemic law can be definitely overcome, and sanitary measures have a higher prospect of success than is possible apart from the production of artificial immunity; and in other acute infectious diseases, except possibly measles and influenza, the epidemic peak of cases may be kept at a lower level, and even in these two diseases the fatality from attack may be reduced.

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[1] See an interesting "Historical Note on Farr's Theory of the Epidemic," by Dr. J. Brownlee, *British Medical Journal*, August 14th, 1915.

Epidemiological investigation enabled Farr on more than one occasion to assume the rôle of a prophet, *warning the public of impending dangers*, thus fulfilling one of the highest duties of a vital statistician. His report on the cholera epidemic of 1866 contains a striking instance of this. A Parliamentary Committee in somewhat halting language had said in that year: "On the recent outbreak of cholera in the East of London it was ascribed by the Registrar-General to the bad quality of the water supplied by the East London Waterworks Company to a part of the East of London." On this Farr remarks: "The Registrar-General had to speak in the midst of a tempest, and on his words at the moment the fate of the ship to some extent depended. . . . . " The charge against the water supply, Farr agreed, was a serious one, but he adds: "It will be evident that the elements of a judgment existed in the accumulated experience of the previous epidemics, in the known laws of the disease, and in the facts of the case looked at comprehensively." Thus, although prompt alarm was given, it was based on careful induction from ascertained facts, and Farr happily had the courage to apply the special knowledge in his possession. At that time Farr combined in part the functions of statistician and of a public health adviser, and although these rôles sometimes are now separate, the need for accurate, complete and prompt statistical evidence concerning local incidences of disease remains.

Happily it has become possible to secure the intensive investigation of individual cases of disease, by means of which differential circumstances and crucial facts can be ascertained, and thus the indications furnished by mass statistics can be checked and made more exact.

Limitations of value of massed statistics. Two earlier statistical studies of Farr may be used here to illustrate the fact that in massed vital statistics we are concerned with aggregates in which, if a causal inquiry is being held it cannot be ensured that the causal factor is adequately isolated from other causal factors which may be acting at the same time. This difficulty, it may be remarked in passing, is a chief source of error when such complexes as poverty, crime, divorce, prostitution are erroneously regarded as simple phenomena the connection between which and some alleged cause can be ascertained statistically with ease. Thus infant mortality is directly related to poverty, but if this knowledge is to be socially useful, we must remember that extreme poverty and prosperity may both be associated with either high or low infant mortality—and that in any local investigation the complex "poverty" and the complex infant mortality both need to be further investigated before it can be decided what are the chief factors at work in a particular instance.

In an earlier investigation of cholera, Farr, during more than one epidemic of this disease, found a close inverse relation between elevation above the level of the River Thames and the amount of cholera in various parts of London; but although, probably influenced by Snow's important work, Farr gave statistics of the incidence of cholera in London according to water supply and concluded in 1853 that "it is believed that . . . . the impurity of the water with which the inhabitants of the several districts are supplied is in nearly a direct proportion to the mortality from cholera," he still clung to the necessity of correcting these water statistics "for the effects of elevation." The story cannot be given in full here; but it is clear that Farr at an early stage realized the need for field observations to check results obtained from mass statistics.

Farr's views as to the relation between elevation and cholera were associated with similar views as to the relation between density of population and general mortality. This latter relation consistently emerged for many years in the national experience of England, but more recently it has consistently failed to appear with standardized death-rates, although, as Dr. Brownlee has recently shown, the relation still holds good when life-table death-rates are used. This result is not convincing, for in standardized death-rates equal weights are attached to mortalities at age-groups, whereas in life-table death-rates varying weights are given to these. Furthermore, Farr himself did not always regard the relation between density and mortality as inevitable, as shown by his remark (*Second Annual Report*) that "there is reason to believe that the aggregation of mankind in towns is not inevitably disastrous." And again in the *Twenty-fifth*

Annual Report "mere proximity of the dwellings does not necessarily involve a high rate of mortality; the question is one of spread of infection."

The adhesion of Farr to the views that there was a causal relation inversely between elevation and prevalence of cholera, and directly in a certain proportion between density of population and mortality, exemplifies as already suggested, the essential difficulty of mass statistics, that of unravelling and segregating from a number of coincident factors the factor which is under investigation, and emphasizes the importance, whenever practicable, of supplementing and checking inferences based on massed statistical data by intensive field observations and by experimental data if these are obtainable.

Importance of local comparisons. Farr early in his official career realized one of the most important methods by which statistics could be made useful in promoting reform, viz., the comparison of district with district and of similar comparisons of vital statistics according to social position, occupation, overcrowding and so on. His Healthy Districts Life Table was a successful effort to codify the difference between healthy districts, in which the death rate was below 17.5 per 1000 inhabitants and was regarded as "natural," and unhealthy districts in which the excess mortality over 17.5 was considered to be "unnatural." In 1845–50 there were only 63 districts with a crude death-rate not exceeding 17.5 but in 1881–1890 more than nine times the population in 1841–1850 had a death-rate below this figure, and in 1891–1900 it was found practicable to form a Healthy Districts Life Table based on the experience of nearly $4\frac{3}{4}$ million persons with an aggregate crude death rate of 15.2 per 1000 (standardized 14). The need, when measuring statistically the health of a community or the efficiency of public health and social work, for a progressive advance of the line of division between "natural" and "unnatural" deaths could not be more strikingly illustrated.

Statistics as formulating lines of investigation. Reference has already been made to the value of Farr's statistical work in discovering enemies to health and in pointing the way to reform. Scarcely less important than this and not liable to the possibilities of error arising when inferences are drawn from massed facts, was *his statistical* *function as a setter of problems.* Thus in his report for 1851, drawing attention to the excessive mortality among butchers, greater than in any other class except innkeepers, he asks why? is it diet? or excessive drinking? or exposure to heat and cold? or the effluvia from decaying matter? here setting out some of the lines of an exhaustive inquiry into occupational mortality, in which, as in Dr. Snow's house-to-house inquiry in 1854 into the incidence of cholera in the areas of supply of two water companies, irrelevant items might step by step be eliminated. In the front rank among the important uses of vital statistics on a large scale stands their value as the necessary initial step to more detailed statistics in which is investigated the association or lack of association between successive "suspects" and the phenomenon under investigation, as for instance the cause of the excessive rate of mortality of innkeepers or butchers.

Already reference has been made to two illustrations in Farr's work of apparent causal relationships which did not penetrate into the inner arcana of truth. In his partial endorsement of some of Florence Nightingale's statistics as to excessive mortality caused by hospitalization, there may have been similarly some non-recognition of the disturbing factors implicated in the statistical comparisons that were made. But in view of the defective statistics with which he necessarily worked and of the complexity of the factors involved in many of the statistical problems which he examined, the sparsity of blunders is most surprising. He had learned the statistical lesson which has been well expressed in Moxon's words: "Overscrutinizing insufficient evidence does not make it more complete." That refinement of mathematical methods will not compensate for the inadequacy or heterogeneous nature of the data collated is a lesson which we still need to bear in mind.

When we remember the terrible hospital records of pyemia in the pre-Listerian period we cannot be surprised that Florence Nightingale should write as follows:[2]

> I have come to believe that the hospital system is an intermediary stage of civilization. At the end of a life spent in hospital work, to this conclusion I have always come—that the poor are always better relieved at their own homes.

---

[2] Quoted from p. 56, "Twenty Years in Parliament," by W. McC. Torrens, 1893.

and that Farr, like other able men of her generation was commandeered to provide the necessary data for her active and persistent advocacy of reform in hospitals as elsewhere. Into the errors which were committed in comparing "bed death-rates" without allowing for the varying frequency of change of occupation, and in comparing results of surgical cases in different hospitals without allowance for the varying initial severity of the cases it is unnecessary to enter. We now know that in modern circumstances hospital treatment secures better prospects of recovery in most cases than home treatment and that while puerperal sepsis, for instance, is still not uncommon in domiciliary midwifery practice, it is rare in lying-in hospitals.

But the relationship between Florence Nightingale and Farr deserves a fuller note. The Lady of the Lamp herself was a "passionate statistician," as Goschen described himself. She had early been impressed by Quetelet's work. Adolphe Quetelet (1792–1874) was born eleven years before Farr, and his earlier writings on meteorology, especially on the law that the date of flowering of each plant is related to the summation of the squares of preceding daily temperatures, had greatly interested her. There is a reference to Quetelet in the following unpublished letter which I am permitted to quote: it was written by Miss Florence Nightingale, in June, 1883. This letter, with other information bearing on Farr's life and work, has been deposited in the library of the London School of Economics, by Mr. W. J. H. Whittall, F.I.A., who has recently endowed a Farr medal in connection with the London School of Economics.

> I trust that Dr. Farr's life will be written at once. It is not like a political life which involves the reputation of living persons. . . . You will understand better than I do myself what a great debt we owe him who, with M. Quetelet, we may say originated the practical application (at least organized it) of a science without which all other sciences—moral, social, political or administrative—could not exist as sciences at all. I mean, organized the verifying and registering by statistics the results of social habits, politico-administration systems, etc., with a view of determining what our course shall be in future.

It may be added that a complete account of Farr's life has never been published, though Mr. Noel Humphreys' sketch prefixed to his collection of extracts from Farr's writings published as a memorial volume by the Royal Sanitary Institute, gives much valuable information.

For many years Farr, like several other distinguished men was at the beck and call of the imperious lady statistician and very influential reformer of nursing and of medical care in hospitals and in the public services and in India.

I have had access to a number of personal letters from which a few extracts may be taken. Here is a letter written by her June 5, 1859, which concludes with the request, almost a command:

> Would you be so kind as to consider these matters and give us your opinion upon the whole of them.

It is convenient at this point to complete our references to Farr's personal life. Early in 1842 he married a second time, and had eight children as issue of this union. He pursued his beneficent official work, supplemented by many valuable contributions in the proceedings of the Royal Society and the Statistical Society until 1880. In the preceding year his official chief, Major Graham had retired after 40 years service. Farr's partnership in work with Major Graham had been one of unbroken friendship, Major Graham repeatedly acknowledging the services of his more distinguished subordinate. Although Farr was now seventy-two years old, he had a great longing to be called Registrar General even though his tenure of this office would necessarily be very short; and the letters quoted below have much interest in this connection, as well as because they illustrate the supremely high reputation which Farr had achieved.

Writing to Farr on June 10, 1879, in evident reference to Farr's application for the higher post, which was in the gift of the Prime Minister (then Benjamin Disraeli), Florence Nightingale, after referring to another matter in which she was asking for Farr's help, ended as follows:

> May God bless your labours, may He entirely preserve your health, may you be our Registrar General, is the fervent wish of, dear Dr. Farr.
> Yours very faithfully,
> Florence Nightingale.
> August 6th, 1879.

Evidently Farr had also asked the help of that great philanthropist, the first Earl of Shaftesbury, whose letter is interesting:

> Dear Dr. Farr,
>
> I quite approve of your letter to the Prime Minister.
>
> I will enclose my letter of recommendation to him for your appointment to the office of Registrar General.
>
> But a single letter from me would be of no avail,—nay the reverse.
>
> Yours,
> Shaftesbury.

For years abroad and at home Farr had been regarded as Registrar General; and it appears that the Prime Minister now took some trouble in the matter, only refusing the application, it has been stated, when on the report of his physician Farr was stated to be suffering from incipient "softening of the brain."

Farr at once resigned, and January 9, 1880, he received a letter from Florence Nightingale, from which the following extract is taken. She had endeavored to obtain some augmentation of Farr's pension and in reporting her temporary lack of success she concluded by saying:

> I wish you many and very happy New Years in the highest sense of the word. Your work will remain and grow for all time for Europe as for England and India.
>
> Illness and business weigh heavily upon me: it is the last straw that breaks the camel's back: my last straws have been tons. . . . and my back is broken, but nevertheless
>
> dear Dr. Farr,
> Am I ever yours devotedly,
> Florence Nightingale.

Farr died on April 14, 1883.

His character is best seen in his writings. Of his genius there can be no doubt. He had a large and open mind, generous to a fault; and the last quality made him the occasional victim of speculative schemers, who presumed on his belief in the rectitude of others. He was absent-minded and forgetful. Once having kept a friend waiting for him in the church while he attended a meeting, he left the friend in the church and went off to the railway station, where an hour later his friend found him reading Lucretius while waiting for his train!

He had a vivid play of imagination, and could write even more picturesquely than John Simon. But above all he had a burning zeal for reform, and was a hygienist through and through. He devoted both his scientific skill and his literary powers to the chief aim of his life, the uplifting of the condition of the people. He stands worthily alongside Edwin Chadwick, and if there be doubt as to which is the greater man of the two, there can be none as to which of the two was the more lovable.

Sans Tache

Sans Tache

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